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FEBRUARY 2, 1928

Engineering News-Record

Lake Pleasant Dam, Agua Fria River, Arizona

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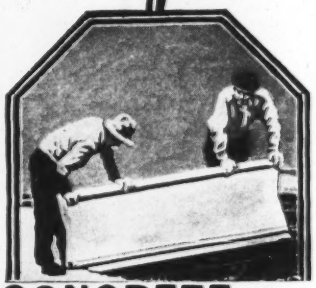

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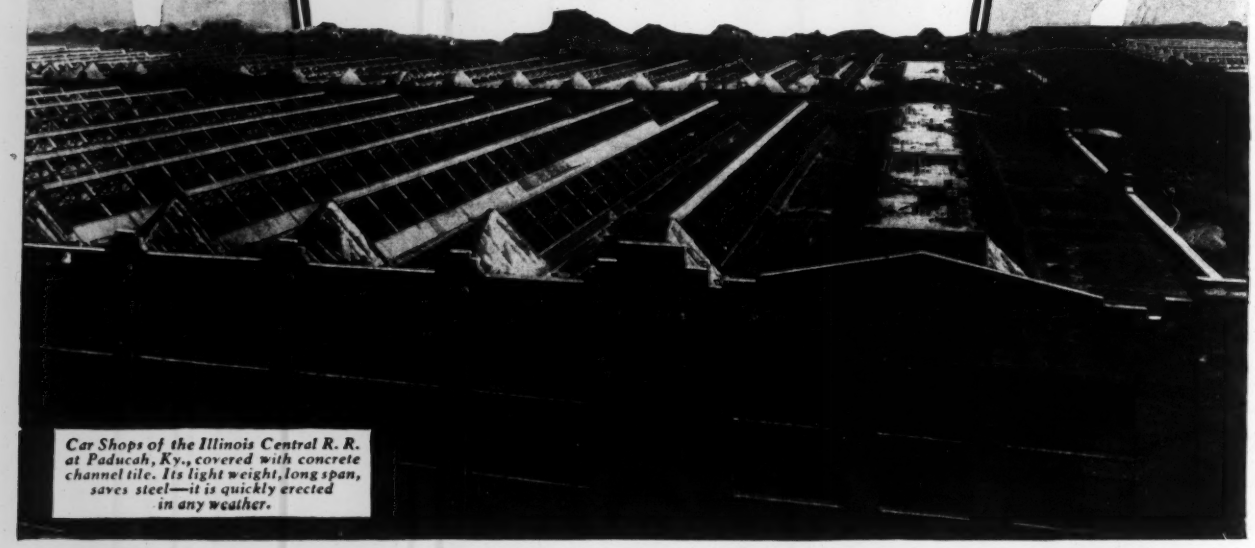

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ENGINEERING NEWS-RECORD

DEVOTED TO CIVIL ENGINEERING AND CONTRACTING

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Contractors Are United

ORGANIZED contracting has arrived. Contractors have learned to group together and take action as associations. At their ninth annual convention, held last week at West Baden, Ind., the Associated General Contractors of America reported more than 2,000 members and upward of 100 local chapters. Obviously this total membership falls far short of all contractors of membership stature, and just as plainly the observer can see that the ties that bind the members and the chapters to one another and to the general association are tenuous. But there is now union where eight years ago there was none. To have gained so much is high accomplishment. Probably it can be named the highest accomplishment of all time in the contracting business, always a jealous and individualistic business. Today contractors are working together in reasonable harmony in association. The interests of efficient construction are the gainers for their co-operative attitude and their will to make further progress through joint effort.

A Case for Counsel

SO FAR the congressional committee hearings on Mississippi River flood control have been concerned more largely with the issue of cost apportionment between the federal government and local interests than with the essential question of how the floods are to be controlled. Some slight consideration has been given to the technical phases of the problem, but virtually none to the organization and management of the work. Yet this is the controlling question before Congress, as we pointed out more than a month ago in commenting on General Jadwin's recommendations. The task to be accomplished is not one of mere large-scale expenditure for routine operations; on the contrary, pioneer work is required, calling for the highest type of creative ability and judgment in developing sound methods. Moreover, as yet not even the broad outlines of the work are known, a fact revealed most strikingly in the disagreement on plans and estimates between General Jadwin, with his $300,000,000 project, and the Mississippi River Commission, with its $700,000,000 project. There is no present assurance that either of the two plans is safe. For these reasons many months, even years, of thorough study are required before a dependable plan for the control work can be laid down. Yet construction work cannot await this outcome, but must be started the moment winter is over. Research and study must therefore go hand in hand with design and construction, all in a well-knit program of operations guided by men of the highest engineering and administrative ability. What type of organization shall be set up to do this? The question is for Congress to answer. It need not now conclude finally on cost apportionment nor on technical plan, but it must without fail decide how the work shall be organized. The ultimate success or failure of the whole enterprise depends on the administrative plan. The problem is one for which Congress will need the advice of competent counsel from engineers and executives who have created large works for industry or for public service. If Congress will seek their advice, it can discover the right course; without such counsel it runs the risk of failure.

Ten Years Too Long

NOW that criminal prosecution on charges of nepotism, padded payrolls, joy rides, worthless work and no work at all in connection with the New York state census has been recommended by a special commissioner of investigation, presumably there will be a renewal of the talk of some months ago against a state census halfway between United States censuses. Fortunately the special commissioner takes a firm stand for the intermediate state census. Reform rather than abolition of the state census is advised. There are many social and other questions dependent for their answers on a census oftener than once in ten years—not alone in New York but in many other, if not all, the states of the Union. Whether it is necessary to go much beyond a count of human heads and certain closely associated particulars oftener than once in ten years is open to discussion. Since for many years we have had a permanent federal Census Bureau there is much to be said for at least a population count for the entire country every five years. Until this is done, the states with largest urban population could with great benefit take at least a population census in every year ending with five. There are scores of social and engineering studies and planning for which ten years is too long a time to be dependent on guesses of population.

Intermediate Type Roads

A TREND toward the development of intermediate type highways is evident. Without prejudice to paved road needs there has grown up a powerful demand for a less permanent type but one which excels the traffic-bound road in dustlessness, endurance and load-carrying capacity. In most parts of the country the type has been sought in some form of tar or asphalt treatment of the natural soil surface or, more often, treatment of a surface of gravel or fine stone placed previously, or at the time of improvement, on the natural surface soil. The types of bituminous surfacing may be approximately classified as surface treatment, mixed-in-place surfacing and premixed surfacing. Each presents many variations in materials and construction methods. All are giving service, whatever their differences in detail, which is encouraging extension of use. There is a definite call for investigation as the next step in development. This has been begun by the counts

and summaries made by the committee of the Highway Research Board and by the studies of the California Highway Department and the Bureau of Public Roads. There is much more that needs to be done. Practice shows many vagaries in the choice of oils and in the ways that they behave, in application and service, on different road surfaces. As it now exists, there is too much of a gamble in choosing an oil or a method of treatment for any particular location, climatic conditions or surfacing materials. There is equal uncertainty about the behavior of the completed surface—whether it will spatter, pick up or form corrugations. A process of trial and discard is about all that is available to the road engineer. Consistent and adequate construction practices develop too slowly by such methods to meet modern demands in roadbuilding. Oiled surfaces give too great a promise of meeting a demand in road construction to deserve being handicapped by negligence in elementary research.

Making Reclamation Pay

IF PLANS now under way come to successful issue, new life may be given to federal land reclamation by putting the work on a more promising financial basis. This would be accomplished by eliminating the critical element of loss in putting reclaimed land to work—the loss incurred between the time when water is ready to be put on the land and the time when production from the land reaches a net-profit basis. A bill now in Congress would authorize the Reclamation Bureau to develop farms on the projects and finance the starting-in of the settlers on long-term amortized payments. Contributing elements of the loss in question may be grouped under two general heads: (1) Slow development, and (2) the individual farmer's financial burden while creating his farm and bringing it to full production. If it is possible to do away with slow development and if the starvation conditions in the early years of the farmer's enterprise are bettered, an obvious improvement will be made. The first may be accomplished by setting up the project in such manner as to bring about substantially complete settlement and cultivation in a short time, thereby cutting out the overhead losses. This means putting organized and controlled settlement in place of exploitational real-estate selling. The second may be accomplished by helping the individual farm to get into full production quickly and without the crippling effect usually inseparable from farm financing in its first stages. Both of these ends can be attained by settling the farmers on developed farms instead of settling them on raw desert. But neither this nor controlled settlement is possible under the laws that now govern the operations of federal reclamation. Congress has learned much about the reclamation problem in recent years, however, and there appears to be a chance that it may soon come to recognize the merit of the business procedures indicated—methods exactly the same as those used by all successful private land developers. As early as two or three years ago a bill to authorize a working-scale trial was introduced in Congress by Senator Kendrick, but it did not attract enough support. The present state of reclamation is a hopeless one, as we have pointed out more than once in recent months. The plan now under way offers the one single course remaining open for making reclamation pay.

Salvaging Municipal Rubbish

SEPARATED by 3,000 miles, Baltimore and Los Angeles are the chief if not the only cities in the United States now attempting to reduce the cost of rubbish disposal by sorting out and selling such of it as has commercial value, the tailings being incinerated. These are new ventures for both cities. The Los Angeles salvaging plant was described in our columns March 31, 1927, p. 526. The two plants at Baltimore were described in our issue of Jan. 26, p. 152, with operating results for one year for the older one. Four facts regarding the Baltimore salvaging plants deserve comment:

1. The original project at Baltimore called for four or five plants scattered about the city—presumably to save mileage and cost of hauling. Opposition to proposed sites led the Baltimore officials to concentrate rubbish disposal at two points. Experiences like this not only at Baltimore but also at Philadelphia, St. Louis and elsewhere must be reckoned with by engineers and city officials.

2. Operating experience with the first of the Baltimore plants showed that the incinerator would not burn the tailings when the latter were wet. It was even necessary to get into the furnaces and shovel out the mass of stuff that could not be burned. Consequently, the first installation was overhauled at an expense slightly in excess of its first cost. On the face of it, there must have been something wrong with the engineering or the legal or general administrative departments of Baltimore in the drawing of plans and specifications, in conducting contract tests and in accepting a plant which within two years required overhauling expenses in excess of the original cost.

3. Even with a liberal allowance for capital charges, the net cost of salvaging the Baltimore refuse and burning the tailings is but a small part of the cost per ton of collecting the refuse and hauling it to the disposal plant. The table on p. 154 of our issue of Jan. 26 shows total receipts for sales of salvaged material considerably more than half the total operating expenses, thus bringing the "net cost" for disposal per ton down to $0.643. Whether this figure includes overhead, insurance, water, etc., the article does not state. The investment cost in the plant is about $220,000, hence capital charges and other items that should really be debited to the plant might conceivably equal the net operating cost as given or bring the net operating cost plus all other proper charges up to $1.25 per ton. The contract price for collecting the refuse and delivering it to the plant is $5.75 a ton, or five times this figure for disposal. How much the cost per ton (the contract applying to the entire city, which has a large area) might have been lessened had it been possible to reduce the haul by building four or five disposal plants instead of only two is an interesting subject for conjecture, but at the most it would still leave the cost of collection and haulage much in excess of the cost of disposal.

4. Computations based on the figures given in the article show that of the total amount of rubbish delivered to the disposal works only 17.35 per cent was recovered and sold, leaving more than 80 per cent to be put through the furnaces. What percentage of the original total was removed from the ashpit the article does not state. This residue was deposited near by and the cost of that work is included in the net operating cost. Haulage of the

furnace residue to some relatively distant point might be necessary in some cities.

Los Angeles and Baltimore deserve commendation for their handling of waste disposal. In both cities the garbage is delivered to contractors for disposal, going to a hog ranch and to a reduction plant respectively. At Los Angeles a large incinerator has been built to burn refuse from markets and wholesale houses, with no attempt at salvaging. Thus the Pacific Coast city utilizes three different methods of waste disposal. At Baltimore ashes are handled separately—presumably ash disposal at Los Angeles is a minor problem, if it is attempted by the city.

Present indications are that, for the larger American cities, at least, separate disposal of garbage, rubbish and ashes will become—or continue to be—the general practice, but it should be noted that Providence, where heretofore garbage has gone to hogs for disposal, is just now proud of a new incinerator for both garbage and refuse, whereas New York City is slowly but surely, it appears, adopting incineration of mixed refuse.

The outcome of rubbish salvaging is uncertain. However promising it may be at Baltimore and Los Angeles, it has as yet been practiced for so brief a space in those cities, and so little elsewhere in America, as to be experimental. Unwillingness of American cities to practice real accounting leaves the true cost of every system of disposal of rubbish, garbage or ashes uncertain and almost impossible of determination from the incomplete and often misleading figures available.

American and British Engineering

TOO rarely do the editors of our engineering contemporaries across the sea visit the United States and give American engineers the pleasure and profit of reading the resulting impressions. Early last year the editor of our esteemed London contemporary *The Engineer* spent five weeks in a dozen American cities, mostly in the Northeast. Besides attending a national engineering convention, visiting a few engineering schools and being entertained at clubs and elsewhere, his time was chiefly occupied in seeing large electric light and power stations, and a few industrial plants—called "engineering works" in England. The concluding article in "An American Diary" (*The Engineer*, Nov. 18, 1927) contains an interesting summary of his observations and consequent opinions, addressed to the following hypothetical questions:

"Is American engineering better than British engineering? Are American engineers more capable, more industrious, more inventive, more enterprising than British engineers? Can we learn much from them to our profit? Can we apply in our little land practices that prevail in theirs? Do their industrial methods—of which we have heard so much—appeal to the British mind?"

Our British diarist was well aware that this is not an easy list of questions to answer in a few paragraphs. He stated that "no man shall learn America in a few weeks" and that, much as he saw and heard, it could "represent no more than the merest superficies of American engineering and of the opinion of American engineers." He declared furthermore that what he saw was the "varnish, the bright exterior," and that within the space of five weeks he could not "see, save just here and there, the solid material on which the varnish is laid." He might "guess that it is good," as also "that it is not wholly without flaws, loose knots, cracks and shakes which were hidden" from his eyes. As he did not enlarge upon what might be hidden beneath the "bright exterior" and throughout his articles indulged in little but the most friendly criticism, the possible implication of "flaws" may be passed over without comment.

As to whether American engineering is better than British, he says flatfootedly, "no," and adds that "in respect to certain things that we prize it is not so good." There is some satisfaction to Americans in being told, however, that their engineering "is better than it was a score of years ago, both in structures and machines." Where American engineers excel British is in "daring," but he says this rests on the "opportunity" afforded by a large country and on chances for far greater proportionate returns than can be expected in Great Britain. "Put our limitations upon an American engineer," our British diarist states, "and, as history has shown, he is no more original, no more enterprising, than a British engineer."

As to British engineers learning from Americans, our diarist well says there is something wrong when "engineers meet and do not learn from each other"; but as to the adoption of American methods in England, "what is suitable for them is not suitable for us. Each must cut his cloth to suit his own back. Their works, their power stations, the magnitude of their operations, their expenditure on 'research' are too big for us. They would fit us no better than their immense locomotives and waggons" [railway cars].

It should be understood that the opinions cited are based almost wholly on what their author saw and heard in the mechanical engineering field, in the Eastern United States. Presumably his general conclusions would have been much the same had he extended his travels to the Far West and, East and West, had given attention to civil engineering design, construction and operation, including water supply, sewerage, bridges, buildings, city paving and particularly the vast networks of improved highways built and being built by twoscore states, with and without federal aid. But in all these fields of activity he would doubtless have applied his dictum of "daring" because of "opportunity." We shall not quarrel with his summing up, for if the generalization be true that British engineers would have done bigger and bolder things and American engineers smaller and less daring had each been put in the country of the other, then a high tribute has been paid to the engineers of both countries, since the statement means nothing more or less than that every able engineer adapts the scale of his work, his methods, his daring or his caution to the needs and the means of the country or region in which he finds himself. If supporting testimony be needed it is sufficient to point to the engineers of the British dominions, particularly our neighbors in Canada and our friends in Australia, whose works and ways are often more like those in the United States than in Great Britain.

Finally, the conclusions of "An American Diary" are most amicably phrased and—all the better, if unconsciously—avoid that condescension toward foreigners which was the subject some decades ago of James Russell Lowell's illuminating address made while minister to England.

Construction of Multiple-Arch Dam in Arizona

Irrigation Is Main Purpose, but Power Development Is Included—Concrete Chuted From Towers—Spillway Gates—Foundation Difficulties

A CONCRETE multiple-arch dam 2,146 ft. long, known as the Lake Pleasant dam and completed in September, 1927, creates a storage reservoir for irrigation and power purposes to serve the 40,000-acre project of the Maricopa County Municipal Water Conservation District No. 1. A general view of the dam under construction is shown in Fig. 1, while Figs. 2 and 3 show typical portions of the completed upstream and downstream faces. This irrigation project is about 25 miles northwest of Phœnix, Ariz., and 10 miles farther north is the new dam.

Municipal water districts are organized in Arizona as irrigation districts or water conservation districts, for the purpose of community agricultural development, under a statute which defines such organizations as "municipal corporations." They are authorized to vote and issue bonds for acquiring water rights, reservoir sites, canal easements and rights-of-way to utilize water for irrigation and hydro-electric purpose. A study has been made for the Maricopa district as to the economics of developing hydro-electric power in connection with irrigation, by means of additional dams and power canals, but these works are matters of possible future development. The suit over water rights was noted in *Engineering News-Record*, Dec. 8, 1927, p. 926.

FIG. 1—LAKE PLEASANT DAM UNDER CONSTRUCTION
Three steel chuting towers shown, with derrick carrying chute at left. Concreting plant at central tower. Cableway extends from main concreting tower to a timber tower on bank at right.

The Lake Pleasant dam is on the Agula Fria River, a flashy stream whose runoff varies from a minimum of 1½ sec.-ft. to a maximum of 100,000 sec.-ft. It has in general two flood periods, the major from November to March, and the minor covering July, August and September. A large flood may be expected in either period. During construction there was a maximum flow of 60,000 sec.-ft. in February, 1927, and one of 35,000 sec.-ft. in the summer. For the period 1911-1925 the average annual runoff was 245,000 acre-feet.

Design of Dam—The site is in a formation composed of various kinds of rock: basalt, malapi, rhyolitic tuff and igneous breccia. Borings had indicated the greatest depth to bedrock to be 38 to 47½ ft. below datum, the stream bed being 2½ to 6 ft. above datum. On this basis the design for the dam was made. But later borings showed 52.4 ft. to bedrock, and excavation showed that the rock was rhyolitic tuff in several places. As this tends to disintegrate in water, the excavation was carried down into an igneous breccia formation.

Stream flow analysis and irrigation demand indicated a minimum storage of 173,000 acre-feet, requiring a dam 170 ft. high above stream bed. As the site is not suitable for an arch dam, the choice lay between a gravity dam and a multiple-arch or buttress dam. The multiple-arch type was chosen and owing to its height it was designed with double-walled buttresses to take care of the slenderness ratio. This design is shown in Fig. 4. The hollow buttresses, 60 ft. c. to c., are 16 ft. wide for their full height, with the batter on the inside and the upstream faces closed by flat slabs. This makes a 44-ft. clear span for the arches from bottom to top. The springing line is straight. Three-centered arches were used, with the inside radii constant for the full height, making it possible to design a moving form that would fit the arch intrados at all elevations. The arch barrel is increased in thickness from top to bottom by increasing the upstream radius.

The dam as a whole was designed by the monolith theory and the arches by the elastic theory. Its springing line has a slope of 9 horizontal to 10 vertical, while the buttresses have a downstream batter of 0.15 to 1. These two batters practically meet, making the buttress 2 ft. long at top, 15 ft. below the water surface. The upper 16-ft. closure is formed by a spandrel wall between the arch barrels, normal to the springing line; with the crown of the arch barrel it supports the parapet wall and walk.

The normal arch makes a varying depth of water and an unequal loading on the arches, and requires a three-centered arch to keep the tension stresses low. For reservoir full, the combined direct and bending stresses from load, rib shortening and temperature reach a maximum of 674 lb. per square inch compression in the intrados at the abutment at El. —50. The maximum tension of 200 lb. in the arches occurs with empty reservoir. The maximum stress from the load on the monolith is

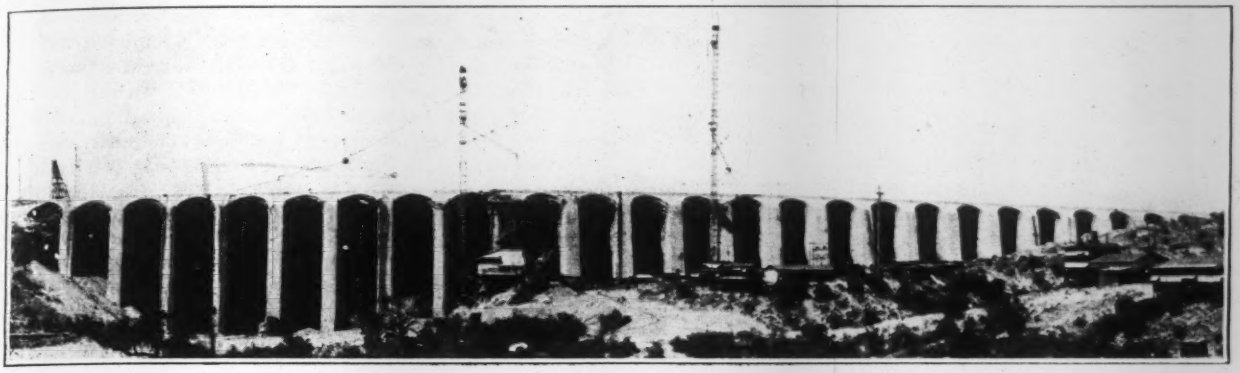


FIG. 2—DOWNSTREAM FACE OF DAM

441 lb. at El. —50 at the downstream toe of the buttress. At the upstream edge of the arch it is 104 lb. Tension is taken care of by about 40 lb. of steel reinforcement per cubic yard of concrete, the dam being more heavily reinforced than most multiple-arch dams.

The dam is 1,830 ft. long on the high water line, and 2,146 ft. to the ends of cutoff walls, not including the 750-ft. spillway. Its greatest height above foundation is 252 ft. It contains 98,400 cu.yd. of reinforced concrete, and the spillway 4,400 cu.yd. Excavation included 60,000 cu.yd. of river bottom and 15,000 cu.yd. above stream bed, besides 40,000 cu.yd. in the spillway. Most of this was rock and indurated material.

Construction Program—In co-operation with the engineering department of the district, the general contractor worked out a construction program on a time schedule basis. It was decided to use towers and chutes to distribute the concrete. Work was started April 15, 1925, building the camp and a road to the dam and assembling the plant. A 7-mile 66,000-volt power line was built, with a substation.

The schedule called for all concrete in river bottom to be poured to El. —10 by July 10, after which floods might be expected. This required three shifts on excavation, placing equipment and spouting concrete. A fire destroyed the screening and concrete-mixing plant, but it was reconstructed by June 29. Excavation was started May 11 with a 2-yd. slack-line cableway; two 1-yd. gasoline dragline machines were added later. Except for the draglines and a steam hoist to pull the pumps out in case of current failure, all power was electric, with a maximum connected load of 1,200 hp.

Dewatering the hole was handled by an 8-in. and two 12-in. vertical pumps. After the gravel had been drained out for some days the inflow to the excavation across the stream bed was only 3 or 4 sec.-ft.

Flood Protection for the Work—Two gaging stations were established, one about 45 miles above the dam on the Agua Fria River, and one about the same distance on its main tributary, Black Canyon Creek. These stations were maintained until all danger from flood damage had passed, and gave warning of such floods as occurred.

The plan of river control was to excavate to bedrock on the west or shallow side and pump all the inflow, allowing none to pass the work, then to concrete this part to stream bed before the July floods, and continue pouring buttress 6 (in middle of stream) to 20 ft. and build a wing dam at each end so that summer floods could be passed over the completed foundation on the west side. The flood protection works, consisting of gravel fills with sandbags on the stream side, were carried up nearly to El. +20 and curved from the banks on the east side to buttress 6. Above the buttress the toe of the slope was protected by tongue-and-grooved sheet piling where the channel restricted it. These works successfully handled all the floods.

Work on Main Dam—Concreting began June 24, 1926, in the west side foundation and was continued in three shifts. By the middle of July it was completed to stream bed and the protection works were so far completed that the first flood did no damage. Excavation was then continued inside the river protection and on buttress 6 on the east side. As suitable bedrock was not found where expected, it was necessary to go to a depth of 80 to 90 ft. for the foundations of buttress 7 and about 60 ft. for the toe of buttress 8.

The contractor decided to build the upstream heel of

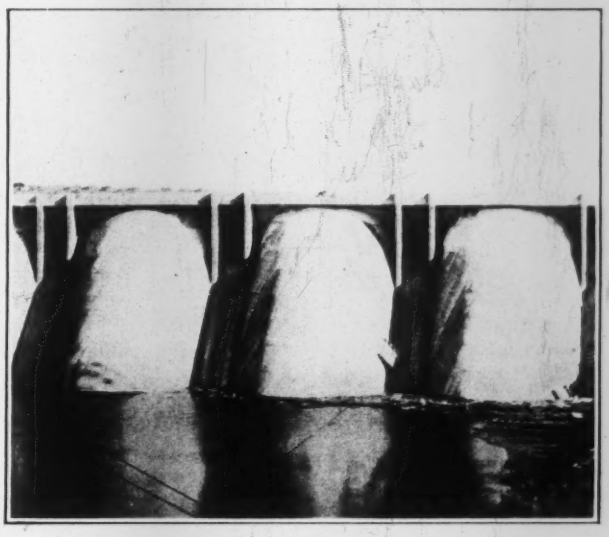


FIG. 3—DETAILS OF UPSTREAM FACE OF DAM

the dam to bedrock first, as the greatest depth to rock there was 47½ ft. and this would give him an upstream cut-off wall across the stream bed. At his instance the plans were changed to give one vertical arch instead of two inclined arches in the deep section of the upstream heel between buttresses 6 and 8. The inclined arch barrels were broken-nosed to fit this vertical arch. During this time, excavation was progressing on the remainder of the work above stream bed and on the deep buttress in the river bed.

After going through caliche and rhyolitic tuff an

igneous breccia was struck at about El. —65. Tests on 4-in. cubes by the State Highway Department showed an average crushing strength of about 1,200 to 1,500 lb., which was not sufficient. Excavation was continued and additional tests showed that the breccia got somewhat stronger with depth and developed an average of 3,000 lb. at El. —81, the deepest point of foundation. This condition applied only to the downstream toe of buttresses 7 and 8. Upon the completion of this excavation, concreting was started in the form of a column to support the enlargement of this cofferdam excavation to the full length and width of buttress 7. This was the most difficult part of the work. Upon its completion, concreting was started and the whole structure was rapidly carried to stream bed. Poor rock at buttresses 12 to 18 made a deep cutoff trench necessary, averaging about 40 ft. and reaching a maximum depth of 80 ft. below ground.

The remainder of the work consisted mainly in pouring concrete. The forms for arches and buttresses were composed of panels which had been built in advance.

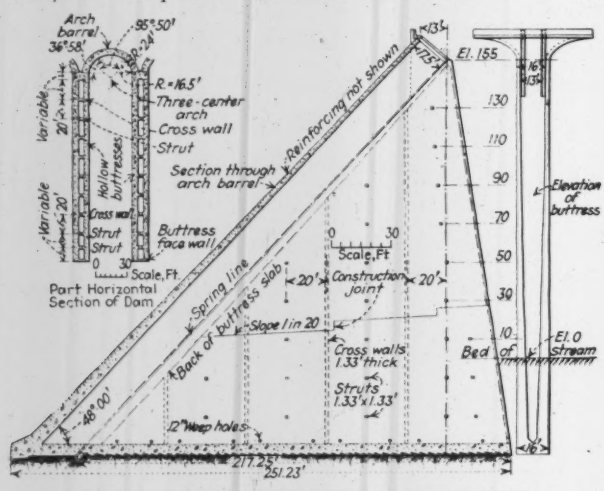


FIG. 4—DESIGN OF LAKE PLEASANT DAM

Each arch barrel had a structural steel supporting form that could be raised on a track carried on bolts left in the concrete at the springing line. These forms were raised after each pour and worked very satisfactorily.

Concreting Methods—A central mixing plant on the east bank, behind buttress 10 (see Fig. 1), included a gyratory crusher, bucket conveyor, revolving screens, washing plant, and 200-yd. bins for three sizes, 3 to 1½ in., 1½ to ¼ in., and sand. From the bins the material was measured in batch hoppers and inundators and fed by gravity to two 2-yd. mixers which delivered the concrete to the base of the central steel tower, 280 ft. high. Practically all the west side of the dam was reached by chuting from this tower across the river to the west steel tower and re-elevating for distribution.

For the east side, the concrete was distributed from the central tower to a 300-ft. steel tower, rehoisted and again chuted to a 100-ft. steel derrick on a 70-ft. wooden tower. Concrete was not re-hoisted at the derrick, which was used merely to swing the chute. For the last few arches and the cutoff wall at this end, the concrete was hauled by dump trucks, but the quantity was very small. For chuting, the slope was sometimes as flat as 1 on 2, but steeper slopes were more satisfactory.

Two west arches in the stream bed, between buttresses 4 and 5, and 6 and 7, were not completed above stream bed until after 1926. During this time the rest of the dam was being finished to El +92. In the spring of 1927 these arches were built, but two square openings, 10x7 ft. were left at stream bed between buttresses 5 and 6 to pass summer floods. A chute was left inside of the arch barrel and the concrete closure was made July 15, 1927. By Nov. 10 there was 110 ft. of water behind the dam.

Expansion joints on the water face were provided between the 8-ft. lifts, and four or five arches were poured at a time to reduce the number of vertical joints. The horizontal joints were made in the usual way, with mortise insert in old work and a grout wash before concreting. The vertical joints were made to occur over the buttress legs.

Several hundred pipes were left in place to grout the 2,000 ft. of joint between the upstream concrete cutoff and rock. Although the dam showed very little leakage under 110 ft. head, the grouting was continued. Air at 100 lb. pressure was delivered to the pipes until bubbles appeared in the lake. Then grout was forced in by a grouting machine, the holes taking from ½ to 20 sacks of cement each, generally about two sacks. A system of 1,200 ft. of rock drains behind the deep cutoff wall on the east side is connected to a sump. The leakage is about 3 gal. per minute.

Outlet Works—Three openings 25x8 ft. on the reservoir side, with vertical steel trash racks, form the outlets (see Fig. 1). The velocity of water through the racks will not exceed 3 or 4 ft. per sec. These openings taper to three cast-iron transitions embedded in the concrete. On the 72-in. outlets are bolted three 72-in. butterfly valves, two for future hydro-electric power and one reduced beyond the valve to a 66-in. penstock, 98 ft. long, of ½-in. riveted steel, ending in a regulating needle valve 66x48 in. The valves are all hand operated but with provision for future power operation. The center line of the outlet works is at El. +35, but there is practically no storage capacity in the reservoir below this elevation.

Spillway—A natural saddle about 1,000 ft. from the west end of the dam is utilized for the spillway, Fig. 5, which is a concrete buttressed structure with 29 tainter gates 25 ft. long and 16 ft. high. The tops of these gates are 1 ft. below the parapet wall on the dam, allowing the complete utilization of storage up to the capacity of the dam. The spillway is designed for a capacity of 150,000 sec.-ft., which is about 50 per cent in excess of the largest recorded flood. Its buttresses, 25 ft. c. to c. and 2 ft. thick, rest on a horizontal slab with a cutoff wall and support a horizontal slab with a track for the car operating the gates. Material for the spillway was handled from the west end by a tram car on a trestle and pulled about 1,000 ft. by a cable. Concrete was distributed by a dump truck.

The bearings for the gates are supported by tie-rods extending to the upstream heel of the buttresses and two rods at right angles to these. These rods were threaded so that the bearings could be adjusted 1½ in. in any direction. The buttresses were cast with the rods and boxes in place, as shown in Fig. 5, but the concrete was not cast around the boxes until the gates were placed and adjusted. This structure required about 40,000 cu.yd. of excavation, 4,400 cu.yd. of reinforced concrete and 600,000 lb. of steel in the gates.

Camp—About 600 men were employed. The camp consisted of tent houses, with floors, for the laborers; frame houses for the foremen, a mess hall, general store, recreation hall, bath houses, hot and cold water, electric lights and a sewerage system.

Power—Two 66-in. outlets at the main dam provide for a power plant to utilize the flow of the irrigation and spillway water, while ordinarily one 66-in. emergency outlet or blow-off would be sufficient for the irrigation service. In the original main canal there were six drops, but a relocation has concentrated the fall in one 80-ft. drop by an open chute which can be replaced by a 2,100-ft. penstock to serve a power plant.

Two plans were worked out; one to develop 6,300 kva. at the dam and 3,400 at the canal drop; the other to develop 5,000 and 2,700 kva. respectively. The first plan provides for multiple wheels to utilize low flow and make the available output meet the calculated demand for power for irrigation pumping. The second plan provides for a single wheel at each plant and will not meet the irrigation pumping demand in the winter. The output from the larger and smaller plants would

FIG. 5—SPILLWAY, WITH DECK FOR OPERATING GATES

average 30,300,000 and 27,800,000 kw.-hr. per year, respectively. No decision has been made as to the installation.

Water Distribution—Water flows in the river channel from the main dam to the diversion dam, 1¼ miles. This latter is of a gravity type, of rubble and concrete construction, 1,200 ft. long and 75 ft. high above the foundation. The head works of reinforced concrete are located at the east end. From this dam a 500-sec.-ft. canal follows the river on the east side 4½ miles to the crossing, which is a steel flume of 500 sec.-ft. capacity, 1,215 ft. long and carried on three-pile bents with concrete footings.

The main canal then follows the west bank for 4 miles, then west and south 24 miles along the west side of the project, diminishing from 500 to 50 sec.-ft. capacity as laterals are taken off at each section line. The sub-laterals generally run south on each section and half-section line. Except for the river crossing, the highway crossing, concrete siphon and concrete chute leading to the flume, all canal structures are to be of wood.

Progress—Financial arrangements were completed in March, 1926. Construction equipment was ordered at once and the dam was completed in September, 1927, which is considered a remarkably short time for a structure of this type and magnitude. Up to Nov. 1, 1927, the main dam was 94 per cent completed (with all concreting done); diversion dam, 90 per cent; outlet works, 91 per cent; spillway, 92 per cent (with concreting done and all gates set); river crossing, 40 per cent, and main canal 37 per cent (with practically all excavation done). Contracts will be let soon for the laterals and sub-laterals.

Engineers and Contractors—The dam was designed by Peckham & James, consulting engineers, in collaboration with C. E. Griggs, chief engineer for the district. J. G. Bailhache, assistant chief engineer, had charge of and designed the hydraulic and hydro-electric works. E. A. Noetzli is consulting engineer; A. F. Harter, chief field engineer, has been in charge of all field surveys and location since 1910; R. C. Rutter and James Girand were the resident engineers at the dam. Carl Pleasant was the contractor, with J. G. Tripp as his superintendent on the dam.

Mississippi Waterway Developments

With the extension, in 1927, of barge service to the upper Mississippi River, above St. Louis, by the United States government, through the Inland Waterways Corporation, some of the principal cities on that part of the river are providing or considering terminal facilities for the interchange of freight between water and rail carriers. During 1927 a municipal river-rail terminal was completed at Minneapolis. Similar terminals at St. Paul, Minn., and Dubuque, Iowa, are expected to be ready for the 1928 season of navigation. On the lower Mississippi a municipal terminal was completed at Helena, Ark., while that at Baton Rouge, La., opened in 1926, was improved by the addition of a transfer boat to carry freight across the river. These facilities are all operated by the Inland Waterways Corporation, which also provided a dock and equipment for handling sugar at Reserve, La., and has under construction improved facilities at Vicksburg, Miss., to replace those damaged by the recent floods. This work will be completed early in the present year.

On the Warrior River, operated in connection with the Mississippi River service, the waterway corporation is building a terminal at Birmingport, Ala., to accommodate the increasing traffic of the Birmingham district. A new terminal is also under way at Holt, Ala. As to general rail-and-water terminals serving both seagoing vessels and river craft, the state docks at Mobile, Ala., are approaching completion, while extensions and improvements are under way by the municipal dock commission at New Orleans. An interesting feature of the river navigation is the trial of pulverized-coal as fuel on the towboats. The Carnegie Steel Company is reported to be shipping steel by barges down the Ohio and Mississippi rivers and along the coast to Gulf ports, while the Jones & Laughlin Steel Company is enlarging its private dock and facilities at Memphis, Tenn.

Water-Works Reconstruction in Winter at Newton, N. J.

Concrete Intake and Intake Pipe Hauled to Place and Lowered on Ice—Dam Repaired and Gatehouse Rebuilt

By Harry G. Payrow
Assistant Professor of Civil Engineering, Lehigh University, Bethlehem, Pa.

WINTER conditions were utilized to place a submerged concrete intake and intake pipe in Morris Lake, the source of water supply of Newton, N. J. During the same winter, a gate house was built and repairs to the dam were completed. The most distinctive feature of the winter construction was hauling the intake and the pipe on the ice and lowering each to place through the ice. Actual work began in October, 1926, and continued throughout the winter of 1926-1927.

Morris Lake reservoir is located in northern New Jersey, about 9 miles from Newton. After the lake had been acquired in 1895, a stone masonry dam was built to a height of about 30 ft., replacing a small earth dam. An intake standpipe of steel was also constructed about 600 ft. out in the lake. From this standpipe a 12-in. cast-iron pipe conveyed the water directly through the dam to a point about 1,200 ft. downstream, where it was reduced to a 10-in. pipe leading to the town.

This arrangement served the town for about 30 years but, due largely to ice pressure on the lake, the standpipe intake had been forced out of its vertical position and there was a possibility of the intake completely failing. The stone masonry was also seeping water considerably at certain points in its face. It was decided to abandon both the intake standpipe and intake pipe and construct a new submerged intake and a larger intake pipe, build a controlling gate house and repair the dam.

Repairs to Dam—It was found necessary to dewater the entire upstream face of the dam in order to make proper repairs, and to build into the dam a service gate house. It was also decided to raise the dam 3 ft. A cofferdam was constructed of 4x10-in. slip-tongue wooden sheeting driven by hand mauls. Support for the sheeting was obtained by bracing against the dam. This cofferdam proved exceptionally tight, in view of the fact that there were three right angles formed in making the offset for the construction of the gate house.

Upon dewatering, it was found that the masonry dam had a distinct thick seam of disintegrated mortar entirely through it, in an approximately horizontal direction, from 5 to 8 ft. below high water. It was decided to tear down the old dam to this seam and rebuild with concrete.

The muck inside the cofferdam was excavated down to solid ledge, exposing the entire upstream face of the dam, which was thoroughly cleaned by sandblasting. A reinforced-concrete facing, varying from 2 ft. thick at the bottom to 1 ft. thick at the top, was now built against the upstream face of the dam and bonded to it by means of 1-in. steel pins previously set into the masonry of the dam. Expansion joints were provided at intervals of about 30 ft.

Submerged Intake—Soundings indicated that the new concrete intake could be placed on ledge in about 35 ft. of water. The new intake (Fig. 1) is of unusual design, with the outside cylindrical, and the inside shaped like an inverted truncated cone. The horizontal opening is 72 in. in diameter, tapering to 48 in. at the invert of the spout or connection with the new intake pipe. This spout is 4 ft. long, with an inside diameter tapering from 30 in. to 20 in. The intake was poured on shore in two horizontal sections (Fig. 2), having a total weight of some 18 tons.

About the middle of January, 1927, there was an ice covering of 18 in. on Morris Lake, and it was decided to use this ice to move the concrete intake to its position out in the lake. A trussed sled (Fig. 3) with 40-ft. runners was built of heavy timbers. The runners were trussed to distribute the weight on the ice and to make it possible to lift the heavy intake from the cross-sills, remove the latter and lower the intake to position.

The lower or bottom part of the intake was placed on the trussed sled near the shore by means of a 10-ton gasoline-driven crane on caterpillars. It is estimated that this section of the intake weighed 12 tons, and the sled about 5 tons. A small hole was then cut in the ice,

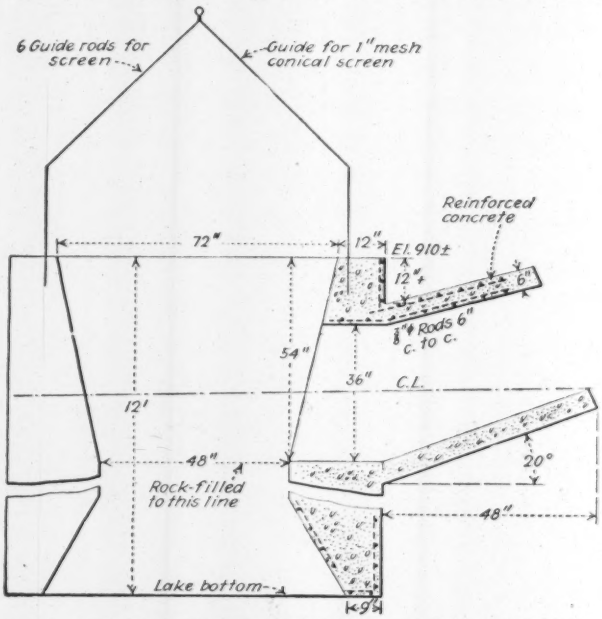


FIG. 1—SECTION OF REINFORCED-CONCRETE WATER INTAKE FOR NEWTON, N. J.

beyond the final position of the intake, in which a cross-log with cable attached was placed under the ice. This served as a deadman to hold a snatch block. A cable from the crane on shore was then run out through the snatch block and back to the sled.

Some difficulty was experienced in getting the sled started, due to the freezing of the log runners to the ice. After the runners were loose, the sled moved steadily out to the proper position. As the sled advanced, it proved to be a critical time, as the ice snapped and boomed in all directions as it sagged with the load. The sled was then made fast to the deadman and the crane line reeved through double blocks in the top of the sled, raising the section of the intake. Immediately the cross-sills were removed and the work of cutting away the ice underneath was started. As the hole in the ice was opened, water gushed up and flooded the ice to a depth of about 6 in. The bottom section of the intake was then lowered and set in its final location. The top section of the intake with the spout was not so heavy, and was

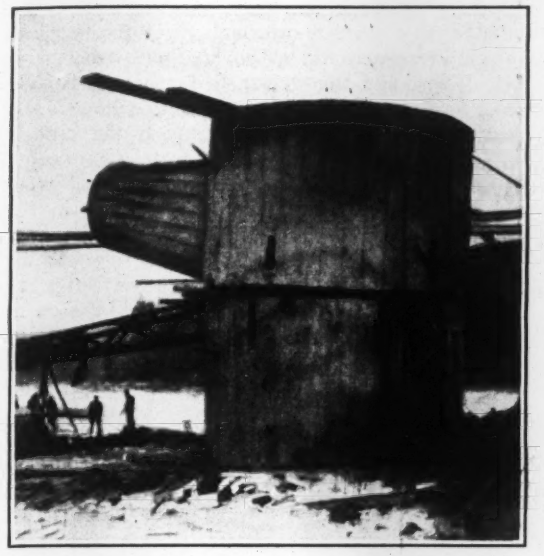


FIG. 2—CONCRETE INTAKE ASSEMBLED ON SHORE
Upper portion raised slightly preparatory to removal.

lowered the next day without difficulty. Immediately following this operation the weather became very warm, which rapidly reduced the thickness of the ice to about 6 in. A diver was required throughout the operation to inspect the foundation and to set the intake to the required alignment. A crushed stone fill was placed around the outside of the intake as well as the inside, up to the elevation of the invert of the spout.

Screen and Guide—A conical screen was placed over the intake. This was made up of $\frac{3}{16}$-in. brass wires, brazed to a frame of $\frac{3}{4}$-in. brass rods so as to form 1-in. openings. At the top of the screen was a brass casting to which the frame was securely fastened. From a ring in this casting a bronze chain extended to a copper buoy in the surface of the lake.

To insure proper seating of the screen on the concrete intake, a guide frame was made up of six 1-in. brass rods set into the top of the intake in precast holes and set with lead and steel wedges by the diver. These rods were brazed together at the top with a ring from which a brass chain extended to the buoy at the surface of the water but passing through a 2-in. opening in the brass casting at the top of the conical screen. In this manner the screen can be raised for cleaning and lowered again to the intake, being guided to its place by the chain and guide rods.

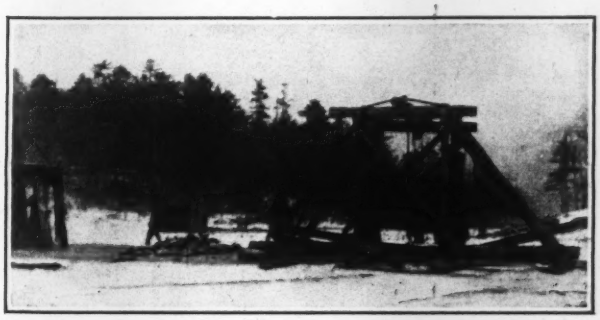


FIG. 3—BOTTOM SECTION OF INTAKE ON SLED
The sled had 40-ft. runners and was used to haul the intake some 250 ft. on the ice to position for lowering from ice to final position on lake bottom.

Intake Pipe—About 600 ft. of 20-in. reinforced-concrete pipe connected the submerged intake with the service gate house. The pipe was designed (Fig. 4) especially for this work by the Newark Concrete Pipe Company.

The laying of the intake pipe began as soon as the walls of the gate house were completed. At this time there was an ice covering of 18 in. on the lake, through which a slot was cut with ice saws on the line of the pipe. The pipe was dragged out on the lake by horses and rolled on planks over the slot in the ice. The pipe was then lowered to the lake bottom by means of chain blocks hanging from a tripod. A diver placed plank cross-sills under the pipe to bring it to the proper alignment and to give it further support. The specially designed bronze tie-bolts which connected with bronze eye-bolts in the ends of the pipe sections were then drawn up, the conical lead joint wedging and forming a water-tight joint.

The water was about 15 ft. deep for 500 ft., but from this point the bottom dropped rapidly until it was 30 ft. deep at the connection to the submerged intake. There were two special concrete castings required; one bend for a horizontal change in the line, and one vertical bend at the point where the bottom of the lake dropped off rapidly.

Gate House—The new gate house is 17½ ft. square, placed against the dam. It was necessary to construct this gate house over the original 12-in. intake pipe while the line was in constant use. Upon the completion of the

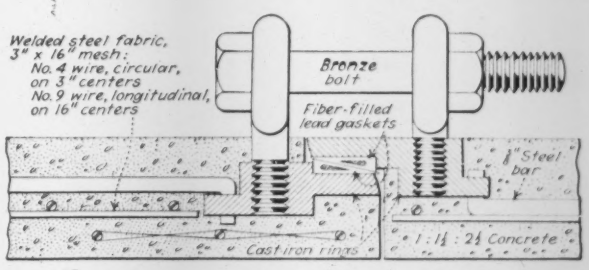

Welded steel fabric, 3" x 16" mesh: No. 4 wire, circular, on 3" centers No. 9 wire, longitudinal, on 16" centers
Bronze bolt
Fiber-filled lead gaskets
¾" Steel bar
Cast iron rings
1 : 1½ : 2½ Concrete

FIG. 4—DETAIL OF FLEXIBLE SELF-CALKING JOINT FOR SUBMERGED PIPE

gate house a 12-in. gate was inserted in the old pipe while under pressure. A section of this pipe was then removed so that the old pipe would serve as an outlet from the gate house. This interrupted the flow about four hours, an equalizing reservoir carrying the demand meanwhile.

A simplex venturi meter was placed in the 12-in. service pipe line just below the dam.

Concrete—All the materials for concrete were heated by means of steam coils placed throughout the piles of aggregate and in the water tank. There was also a kerosene blow-torch which shot a flame into the mixer. The resultant temperature of the concrete after an average of three minutes mixing was 80 to 90 deg. F. All forms were covered, and when possible salamanders were placed around the forms. After seven days the concrete registered a temperature of 45 degrees.

The work was done under the supervision of W. J. Hardin, town engineer of Newton. The contractor was the John W. Heller Company of Maplewood, N. J., with E. W. Steele in charge. The writer was designing engineer in the office of the town engineer.

Maintenance of Flood-Control Works of Miami District

Current Upkeep Operations Conducted to Give Improved Appearance as Well as Maintained Efficiency

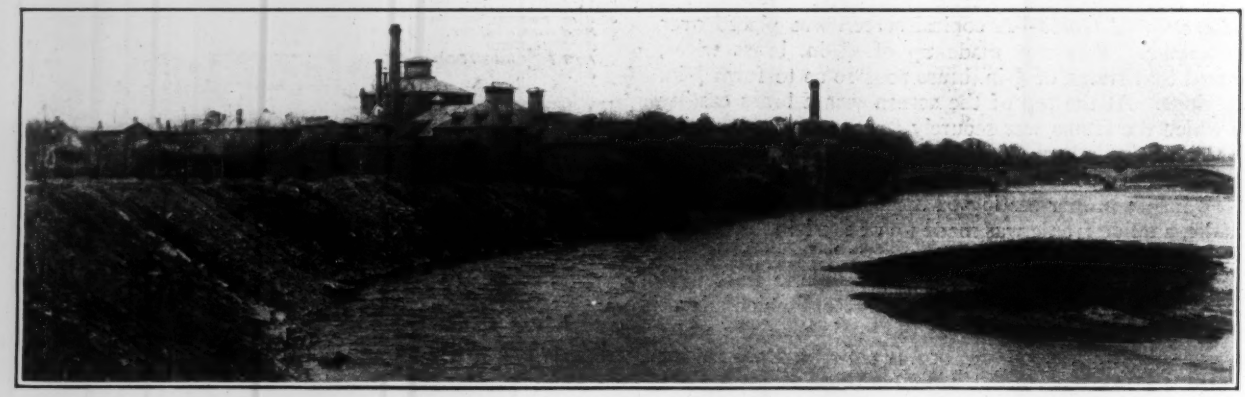
By C. S. Bennett
Engineer, Miami Conservancy District, Dayton, Ohio

THE FLOOD-CONTROL works constructed by the Miami Conservancy District in southwestern Ohio have been in operation for about five years. Most civil engineers are familiar with the general plan of this project, which provides flood control by channel improvement through the cities and towns affected by floods, supplemented by retarding basins formed by the construction of five large hydraulic-fill dams. These flood-control works extend over a portion of the Miami River drainage area, which is about 25 miles wide and 75 miles long, with the city of Dayton near the center of the area.

Maintenance of the works and improvements made by the district is now the principal operation. Such work may consist in simply patrolling the works and making major repairs or it may be developed into a systematic plan for permanently improving the appearance and utility of the works and adjacent lands. The latter policy has been adopted by the officers of the district, and results since the inauguration of maintenance operations seem to justify this procedure. The maintenance operations comprise those in the towns along the streams and those at the dams and in the retarding basins.

Channel Work in the Towns—Almost invariably lands along the banks of streams through cities are unsightly; the banks are irregular and are covered with ashes, refuse or other débris, and the stream bed near the banks at low water is grown up with weeds and willows. Conditions along the Miami River through the cities of Dayton, Hamilton or Middletown were no exception prior to the construction of the flood-control works. Channel improvements and levee construction in these cities did much to better such conditions. The stream beds were enlarged and islands and gravel bars were removed. To facilitate the flood flows the banks were re-aligned so as to provide, as nearly as possible, a uniform width of stream bed through the cities. Levees were built or rebuilt, or concrete walls were erected where lack of space forbade the use of earth levees. In places the lower river slopes of the levees were surfaced with concrete revetment; elsewhere the slopes were sodded or seeded so that a protective covering could be secured. At Dayton and Hamilton large low areas adjacent to the streams were filled with waste material from the channel excavation. All of this work was part of the construction operations.

Maintenance along these improved channels has included further seeding and attention to the growth of a permanent sod on the levee slopes. Various kinds of grasses have been tried to suit the different types of material. On gravel slopes the growth was started with alfalfa and grasses were worked in later. During the growing season small maintenance crews are kept busy removing weeds and mowing the slopes and river bottoms that are exposed when the river stages are low.



FIGS. 1 AND 2—HOW FLOOD-CONTROL IMPROVEMENTS HAVE BETTERED THE APPEARANCE OF THE MIAMI RIVER

In 1918 this river bank was the edge of a dump, as upper view shows; tenements and a brewery building were located just below the bridge. Now, as shown in the lower view, a park and playground has taken the place of unslightly buildings and a dump. Low ground was filled with spoil excavated from the channel. The levee slope is covered with rose and honeysuckle vines to improve its appearance and protect it from scour.

Willows and brush are cut once or twice every season. The tops of the levees, 8 ft. wide, form convenient footpaths. At places where streets end at the levees, or where there is a tendency for pedestrians to go up and down the slopes, concrete steps have been built, to avoid the formation of bare spots on the slopes which would be unsightly and might develop into gullies.

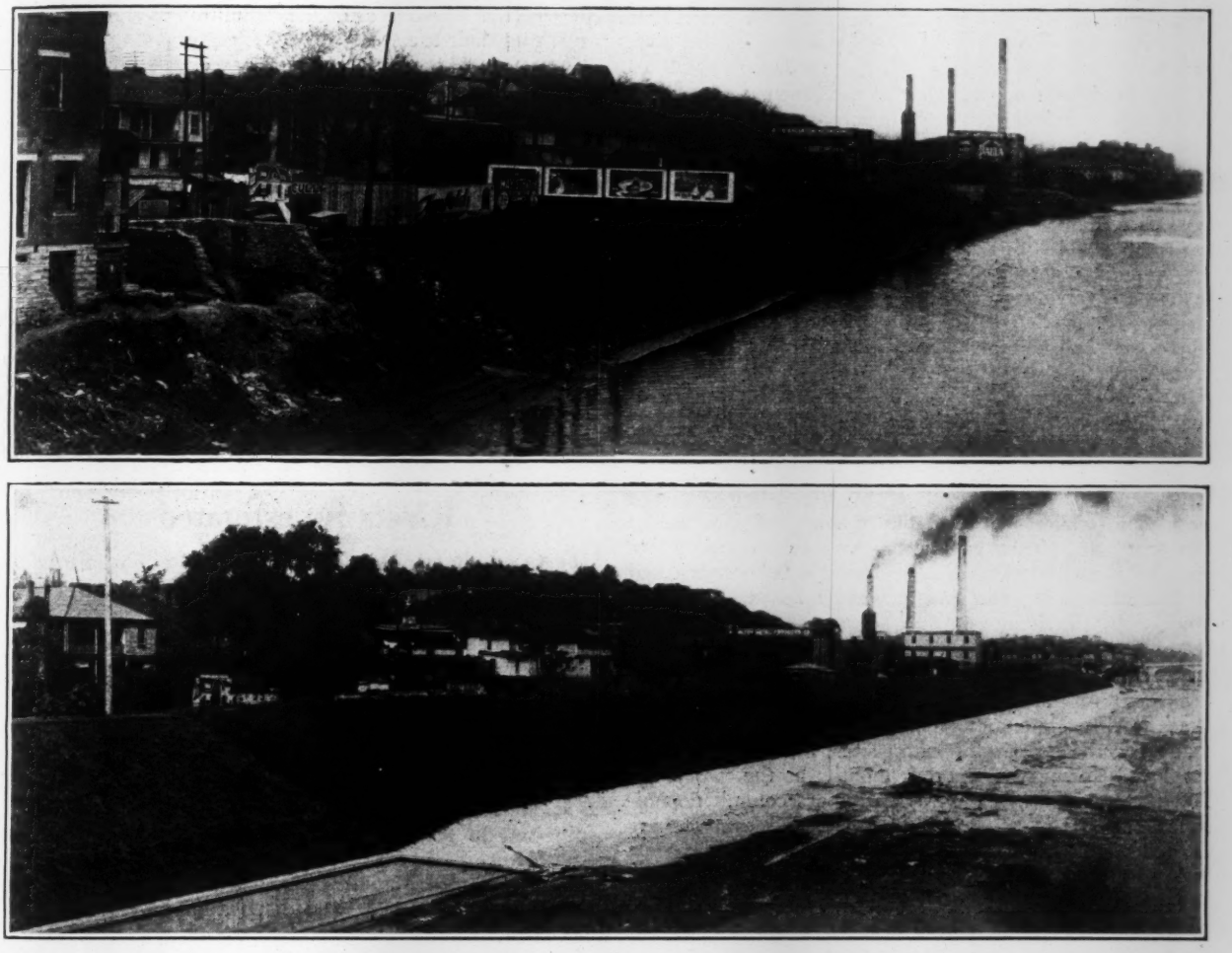
Dumping of refuse or any material over the slopes of the levees and into the streams is prohibited, and signs calling attention to this prohibition have been erected at numerous places along the levees. One of the duties of the levee patrolmen is to see that this regulation is complied with. Any refuse that does happen to get into the river bottoms is removed at the time the weeds and brush are cut.

It is of course important that the improved channels be kept reasonably free of gravel bars or deposits which would tend to reduce the effective area of waterway. Formation of such deposits has been greatly deterred by the installation of commercial gravel plants near the upper ends of some of the channel improvements. By agreement with the district the operators of such plants are allowed to remove material from a specified area, paying a reasonable royalty to the district for the privilege. To further prevent the drift of gravel into the improved channel, low concrete overflow dams have been placed at several places. The largest of these is at Hamilton; immediately above it is located a gravel plant. So far it has not been necessary to remove any gravel deposits from the improved channels.

The areas adjacent to the channel improvements which were filled with waste material had previously been dumps or unsightly holes. At Dayton and Hamilton most of these areas have been turned over to the cities and are being developed into attractive parks and playgrounds.

Where large industrial plants border the river, as at several places in Hamilton, it was not possible to continue the levees along the stream banks. Walls were constructed at these points. Every effort is made to keep the river bed adjoining these properties free from refuse or waste from the plants. This is a difficult thing to do, but much improvement has been made.

Under the provisions of the conservancy law, the officers of the district have complete control of the streams and no structures are permitted in the stream beds or on the banks without the approval of the chief engineer of the district. It has been the policy to restrict as far as possible wire line crossings or other unsightly structures in or over the river within the limits of a town. Designs of new bridges proposed to cross streams



FIGS. 3 AND 4—A HAMILTON RIVER BANK IN 1918 AND TODAY

Conditions as seen in the upper view are common along small streams. A park-like level slope now takes the place of the waste and wreckage of the old foreshore. Weeds and grass on the slope are cut several times a season.

under control of the district must be submitted to the chief engineer for approval as to waterway, clearances, depth of pier footings and shape of pier noses. The district has adopted a standard shape of pier nose especially designed to offer the minimum resistance to floating drift.

Whenever any openings are made in the levees for sewer outlets or pipe lines, such work must be done in a manner approved by the chief engineer of the district, and upon the completion of the work it is required that the levees be restored to their original section and condition.

The patrolman or caretaker at each town makes daily inspections of the levees and channel, reporting to headquarters any matters that need attention. The caretaker also supervises the work of moving slopes, cleaning up and minor repair jobs, and operates the various gates in sewers or other openings at times of high water in the improved channels.

Camping Grounds in Basins—Of the five retarding basin dams three are within 8 or 10 miles of Dayton, the largest city in the district, one is about 5 miles from Piqua, and one not far from Middletown. Considerable areas immediately upstream from four of the dams contain some woods and hilly lands not suited for agricultural purposes. These areas are largely in the basins and are thus subject to overflow, though parts of them are well above the maximum backwater elevation. As these lands must be permanently retained by the district, it was decided to make them available to the public for use as camping and picnic grounds. Available spring-water supplies were tested, and those found safe were marked by suitable signs. The springs were inclosed in concrete boxes, with outlet pipes.

Many residents of Dayton and the surrounding towns, as well as tourists, take advantage of the opportunity to use these grounds, and campers may be found at all times during the summer near the dams. No charge is made for the use of the camp sites, but patrolmen are employed during the summer months at the two most-frequented reserves to see that campers commit no nuisance or destroy trees or shrubbery, and campers are limited to a stay of two weeks at any one site. At two of the dams, game preserves have been established and no hunting is permitted on these lands at any time. Fishing is permitted at all times, except during the spawning season.

Maintenance of the Dams—Maintenance work at the dams is handled by resident caretakers, one at each dam. These men are on the job at all times and make daily inspections of the dams and conduits. They keep weeds cut on the slopes and do such minor repair work as becomes necessary.

As reported in *Engineering News-Record* of July 8, 1926 ("Tests in Growing Vegetation on Gravel Dams," by C. H. Eiffert, chief engineer), considerable experimentation was done before a suitable covering was obtained on the gravel slopes of the dams. Now that a start has been made, care is being taken to improve the growth on these slopes. Each year additional seeding is done, and it is expected that soon the slopes will have a permanent sod covering.

Timber screens, consisting of fast-growing young trees, have been planted across the valleys above some of the dams. The object of these screens is to retard the movement of drift down toward the dams in times of high water. Some bare areas on the hillsides above the dams have been planted with young trees furnished by the State Forestry Department, and it is hoped to increase the area of woods by this means.

As the National Old Trails Road (U. S. No. 40) passes over the top of two of the dams, parking spaces have been leveled off near the dams and made available for tourists who may wish to stop to inspect the structures. Large concrete tablets were erected in conspicuous locations near the end of each dam, on which are given the principal dimensions of the structures and a statement regarding their use.

To sum up, much of the maintenance work is being carried on so as to keep the works attractive in appearance and to provide recreational facilities for the public where possible. By such a policy the flood-control system is kept up to maximum efficiency at all times, and the communities in the district at the same time derive benefits in improved river frontages, park facilities and recreational grounds.

No mention has been made in this article of the other activities of the engineering staff of the district, which include rainfall and runoff studies, observations of flow in channels and conduits, stream gaging operations, etc.

All of the operations of the district are under the supervision and direction of the chief engineer, C. H. Eiffert. The headquarters office building is in Dayton.

Tensile Working Stress for Rivets Investigated

Tests Made for Pure Tension and for Combined Stresses—Lack of Initial Tension in Shafts Shown—A New Formula

By C. R. Young
Professor of Structural Engineering, University of Toronto

(Abstract from paper presented at the annual convention of the American Institute of Steel Construction.)

A SEARCH of current specifications discloses an almost complete silence on the subject of rivets subjected to tension, and to a combination of tension and flexure. While 25 or 30 years ago specifications very commonly prohibited the use of rivets in tension in no uncertain words, the disposition in recent years has been to keep the peace by removing all references of every character to the subject.

A few tests have been made, notably by D. C. Tennant

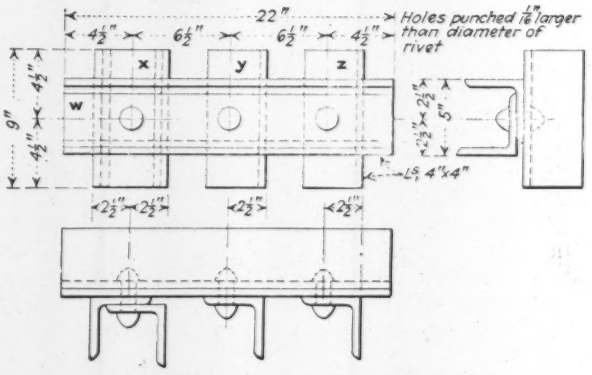


FIG. 1—TYPE OF TEST SPECIMEN USED IN UNIVERSITY OF TORONTO TESTS
In all tests the rivet in crosspiece x was subjected to pure tension load, rivet in y to 1¼ in. eccentric load, and rivet in z to 2¼ in. eccentric load.

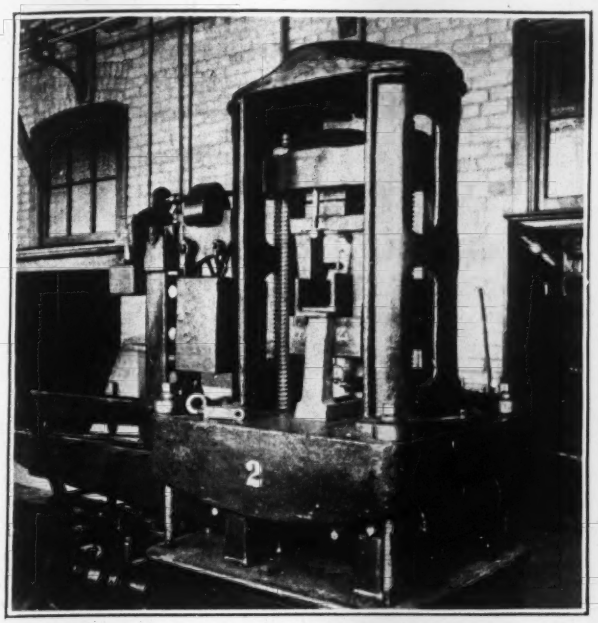


FIG. 2—ARRANGEMENT OF RIVET TENSION TEST SPECIMEN ON TESTING BLOCK

Note—U-shaped steel castings used to subject rivet connecting angles of specimen to tension stress.

at the University of Toronto in 1900, reported in the *Transactions*, Engineering Society of the University of Toronto, 1899-1900; by the Verein deutscher Brücken- und Eisenbau-fabriken, reported in *Der Eisenbau* in 1912; and by the Polytechnic Institute of Brooklyn in 1915, reported by C. R. Hill in *Engineering News-Record*, April 12, 1917, p. 72.

In order to supplement the existing experimental data, the writer undertook during the past summer, under the auspices of the school of engineering research, University of Toronto, a series of tests on rivets in pure tension and in combined tension and flexure. (Tests on combined tension, flexure and shear are in progress, but results are not yet available.)

Test Specimens—Test specimens, Fig. 1, were so planned that in each one the rivet passing through the cross-piece x could be subjected to pure tension, the rivet through the cross-piece y to a tension applied $1\frac{1}{8}$ in. from the center of the rivet measured normal to the axis of the cross-piece, and the rivet through the cross-piece z to a tension similarly applied $2\frac{1}{4}$ in. from the rivet center. In order to reduce as much as possible the effect of dishing in the pure tension test, the cross-piece x, as well as the longitudinal member w, was made of a pair of angles arranged in channel form. Variation in grip of the rivets was obtained by adopting a variety of thicknesses for the angles. On account of the peculiar form of the specimens, the riveting was probably less uniform than would be the case for typical commercial work.

In Fig. 2 is shown the arrangement of a specimen in the testing machine for the pure tension test. U-shaped steel castings were used as loading castings to place the tension stress on the rivets. In the eccentric loading tests, the rivet connecting the cross-piece to the longitudinal member was tested by applying the load to the cross-piece at distances of $1\frac{1}{8}$ and $2\frac{1}{4}$ in. from the gage line of the angles by means of knife-edges attached to the ends of the prongs of the inverted U-shaped casting.

In order that the characteristics of the rivets being tested might be fully known, rivet bars were tested in tension and bending, and careful studies were made of the temperatures of the rivets during manufacture. Careful records were also kept of the temperature of the rivets as they were reheated for driving, and at the commencement of the actual operation of driving.

Pure Tension Tests—Table I contains the results of the tests made for pure tension. The ultimate unit stress, based on the area after driving which is assumed to be the area of the hole, ranged from 48,000 per sq.in. to 72,850 lb. per sq.in., and based on the area of the rivet before driving, from 55,160 to 85,500 lb. per sq.in. The variation in the ultimate strength based on the area before driving is shown in Fig. 3 by the curves x, which indicate that an increase in the grip of a rivet lessens its ultimate tensile strength.

TABLE I—RESULTS OF TESTS OF RIVETS IN PURE TENSION AT UNIVERSITY OF TORONTO

(Note: In the designation of the specimen, the fraction indicates the diameter of the rivet before driving; M indicates that the driving was by machine, and H that it was by pneumatic hammer.)

Specimen	Nominal Grip of Rivet, In.	Total Maximum Load on Rivet, Lb.	Ultimate Unit Stress on Rivets in Lb. per Sq.In. On Area Before Driving	On Area After Driving	Remarks
⅝M	1	23,870	77,850	64,280	.....
⅝M	1½	22,270	72,600	60,000	Head sheared off
⅝M	2	22,370	72,920	60,250	.....
⅝H	1	25,450	83,000	68,550	.....
⅝H	1½	22,740	74,150	61,300	.....
⅝H	2	20,200	65,850	54,420	.....
¾M	1½	37,790	85,500	72,850	Very eccentric head
¾M	2	33,350	75,500	64,300	.....
¾M	2½	30,230	68,450	58,300	Very eccentric head
¾H	1½	34,620	78,400	66,750	.....
¾H	2	31,380	71,000	60,450	.....
¾H	2½	30,430	68,900	58,650	.....
⅞M	1½	41,990	69,850	60,800	.....
⅞M	2	39,930	66,450	57,850	.....
⅞M	3	35,530	59,100	51,470	.....
⅞H	1½	40,345	67,150	58,440	.....
⅞H	2	36,820	61,270	53,380	.....
⅞H	3	33,140	55,160	48,000	.....

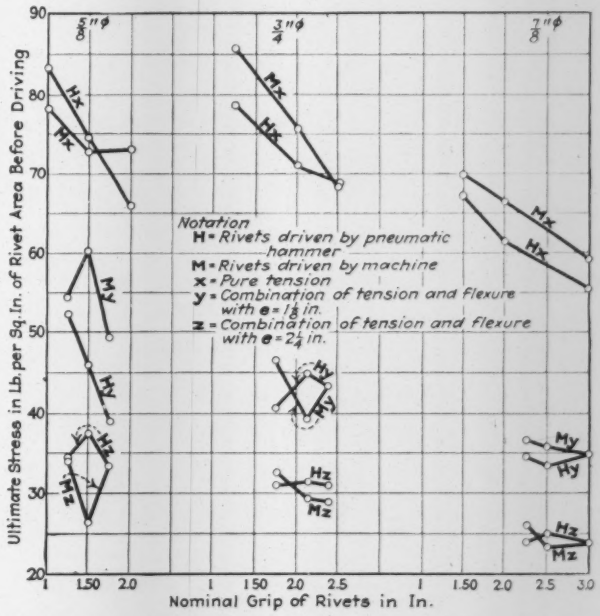

Ultimate Stress in Lb. per Sq.In. of Rivet Area Before Driving
Nominal Grip of Rivets in In.
⅝"ϕ
¾"ϕ
⅞"ϕ
Notation
H = Rivets driven by pneumatic hammer
M = Rivets driven by machine
x = Pure tension
y = Combination of tension and flexure with e = 1⅛ in.
z = Combination of tension and flexure with e = 2¼ in.

FIG. 3—ULTIMATE RIVET STRESSES IN TENSION AND IN COMBINED TENSION AND FLEXURE DETERMINED AT UNIVERSITY OF TORONTO

Ultimate strength of rivets under all stresses decreases with increase in grip. Eccentricity of load lessens strength over pure tension values.

One feature of the study was the determination of the amount of extension of the rivet shaft between heads under gradually increasing loads. By the use of a spe-

TABLE II—RESULTS OF TESTS OF RIVETS FOR COMBINATION OF TENSION AND FLEXURE AT UNIVERSITY OF TORONTO

Note: In the designation of the specimen, the fraction is the diameter of the rivet before driving; M indicates that the driving was by machine, and H that it was by pneumatic hammer.

		Load Eccentricity = 1⅛ In.				Load Eccentricity = 2¼ In.			
Specimen	Nominal Grip of Rivet, In.	Total Maximum Load on Rivet, Lb.	Average Ultimate Unit Stress on Rivets in Lb. per Sq.In. On Area Before Driving	On Area After Driving	Remarks	Total Maximum Load on Rivet, Lb.	On Area Before Driving	On Area After Driving	Remarks
¾M	1½	16,700	54,450	45,000	Angle failed	10,550	34,390	28,420	.....
¾M	1½	18,530	60,400	49,950	.....	8,040	26,190	21,650	Angle failed
¾M	1½	15,130	49,320	40,780	.....	10,220	33,320	27,540	.....
¾H	1½	16,090	52,450	43,360	.....	10,530	34,320	28,370	.....
¾H	1½	14,050	45,800	37,860	.....	11,400	37,170	30,710	Angle failed
¾H	1½	11,890	38,780	32,020	.....	10,205	33,260	27,490	.....
¾M	1½	20,490	46,380	39,510	.....	14,335	32,440	27,630	.....
¾M	2¼	17,230	39,010	33,220	.....	12,900	29,210	24,890	.....
¾M	2¼	19,185	43,450	37,000	Head sheared off	12,735	28,820	24,550	.....
¾H	1½	17,845	40,400	34,400	.....	13,625	30,840	26,280	.....
¾H	2¼	19,820	44,890	38,220	.....	13,810	31,260	26,620	.....
¾H	2¼	19,140	43,330	36,910	.....	13,610	30,800	26,230	.....
¾M	2½	21,915	36,480	31,760	.....	15,620	25,990	22,620	.....
¾M	2½	21,365	35,530	30,930	.....	13,920	23,160	20,170	.....
¾M	3	20,880	34,730	30,230	.....	14,200	23,620	20,570	.....
¾H	2½	20,625	34,330	29,890	.....	14,280	23,760	20,690	.....
¾H	2½	19,870	33,050	28,790	.....	14,840	24,680	21,490	.....
¾H	3	20,790	34,570	30,110	.....	14,390	23,930	20,840	.....

cial extensometer, readings were made which showed that in a considerable number of cases no observable extension of the rivet occurred until a very large amount of load had been applied.

Tests of a Combination of Tension and Flexure—The results of these tests, obtained when subjecting the specimens to loads applied respectively at 1⅛ and 2¼ in. from the gage lines of the cross-pieces of Fig. 1, are given in Table II. A considerable falling off in the average tensile stress developed on the rivet shaft was observed when the load was applied eccentrically, as may be seen in curves *y* and *z*, Fig. 3. Although an eccentricity of 1⅛ in. produced a marked reduction of strength, doubling this eccentricity did not lead to a proportionate further reduction.

Generally speaking, the machine-driven rivets for the specimens loaded at an eccentricity of 1⅛ in. give higher values than the rivets driven by pneumatic hammer, but where the rivets were tested under an eccentricity of 2¼ in., the hammer-driven rivets appeared to behave quite as well as those driven by machine. Evidently the behavior of the angles and other conditions incidental to the specimens had more influence on the strength than the method of rivet driving. As in the case of pure tension, the larger the rivet diameter the less the unit strength.

TABLE III—COMPARISON OF RESULTS FROM PROPOSED FORMULA FOR PERMISSIBLE RIVET TENSILE STRESS WITH TEST RESULTS

(Formula, $p = 21{,}000 - 8{,}000\,d - 5{,}500\sqrt{e}$)

Name of Investigator	Type of Stress	Minimum Test Values Divided by Four, Lb. per Sq.In. Diameter of Rivets Before Driving ¾-In.	¾-In.	⅞-In.	Permissible Tensile Stress by Formula, Lb. per Sq.In.
Tennant	Pure tension, $e = 0$	14,680	.....	.....	16,000
V. D. B. E.	Tension and flexure, $e = 1.47$	.....	.....	*10,880	7,750
Polytechnic Inst. of Brooklyn	Tension and flexure, $e = 1.16$	.....	8,800	.....	9,970
		.....	.....	7,180	8,070
University of Toronto	Pure tension, $e = 0$	16,460	.....	.....	16,000
		.....	17,110	.....	15,000
		.....	.....	13,790	14,000
	Tension and flexure, $e = 1.13$	9,690	.....	.....	10,200
		.....	9,750	.....	9,200
		.....	.....	8,260	8,200
	$e = 2.25$	6,550	.....	.....	7,750
		.....	7,200	.....	6,750
		.....	.....	5,790	5,750

* Diameter of rivet 0.826 in.

Initial Tension—One of the reasons adduced for avoiding the use of rivets in tension is that, as a result of shrinkage of the rivet in cooling, a tensile stress is developed frequently in excess of the yield point of the rivet material. With this view the writer is not in accord.

The initial tension in a rivet shaft may fairly be considered as generated by the resistance to reduction of thickness offered by the plates or other parts connected together by the rivet. It is the writer's belief that no increase of stress on the rivet is possible until the load imposed has exceeded the initial tension existing in the rivet. Experimental support of this view was available in the extension observations on the rivets subjected to pure tension in the University of Toronto tests. Here it was observed, as previously stated, that in numbers of cases no deformation whatever was discernible until a very considerable load had been applied. A further circumstance of importance is that the rivet shafts in most of these tests developed an ultimate tensile strength in excess of the known ultimate tensile strength of the material in standard tension tests.

Permissible Working Stresses—Consideration of the diagrams in Fig. 3 leads to the conclusion that the working stress on rivets in tension should depend both on the diameter of the rivet and upon the eccentricity with which the tensile force is applied. Upon this basis a formula has been devised such that a factor of safety of approximately 4 is maintained with respect to the minimum values obtained in the University of Toronto tests. At the same time, the results obtained in other tests have been carefully considered in determining the formula.

For cases of pure tension, and for cases of combination of tension and flexure, with angles of a thickness comparable to those used in the tests herein reported, the formula for permissible tensile stress is as follows:

$$p = 21{,}000 - 8{,}000\,d - 5{,}500\sqrt{e}$$

in which p = permissible tensile stress on the rivets, d = diameter of rivet in inches before driving, and e = eccentricity of loading on the rivet in inches. In Table III is indicated the relation of the values given by this formula to the minimum test values obtained by several investigators.

Railroad Projected From Haifa to Bagdad

The general manager of the Palestine Railway visited Amman recently and consulted with the Transjordan government regarding the alignment of the railway line from Haifa to Bagdad in Transjordan territory. The entire line will pass through British mandatory territory, will be about 620 miles long and the construction will take three years.

Building a Penstock to Develop a Static Head of 2,561 Ft.

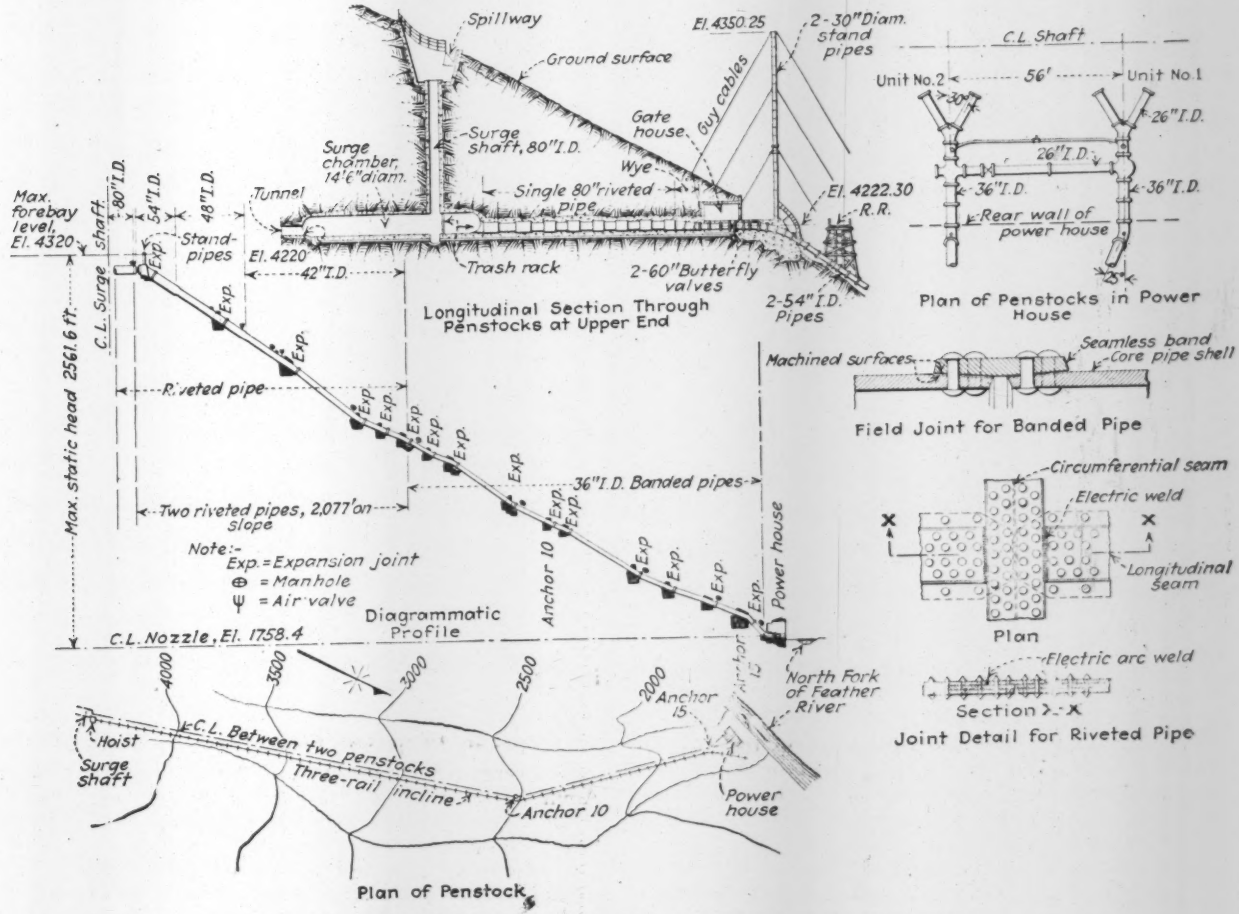
Bucks Creek Project in California—Banded-Pipe Design Checked by Bursting Tests—Joint Detail for Heavy Riveted Section Changed During Construction

By Oswald Speir, Jr.
Designing Engineer, Constant Angle Arch Dam Company

THE DESIGN and construction of the penstocks for the Bucks Creek development of the Feather River Power Company in California are notable because of the high head involved, which constitutes a record for the United States, and because this is the second recent development in California to utilize banded pipe imported from Europe. In this article attention is given to considerations that led to the penstock design, to a few features of shop testing and fabrication, and to construction methods. A general article describing the Bucks Creek development as a whole appeared in *Engineering News-Record*, Jan. 26, 1928, p. 140.

The penstocks constitute the lower end of the pressure conduit between forebay and power house. By means of storage and diversion works on upper Bucks Creek and a tunnel (No. 2) to divert the water into the Grizzly Creek watershed, the natural runoff of both streams, regulated and released as needed, is brought to the forebay on Grizzly Creek, the highest water level of which will be at El. 4,319. From this point a pressure tunnel (No. 1) about 10,000 ft. long on a grade of 25 ft. per mile leads to the top of the penstocks on the hill above the power house. For the most part the tunnel is unlined with a 9x7-ft. section. Concrete lining is used in a few places, including 550 ft. at the lower end, where the rock is seamy, decomposed granite with inadequate cover. A surge chamber excavated in the rock and completely concrete lined is located 145 ft. from the lower portal.

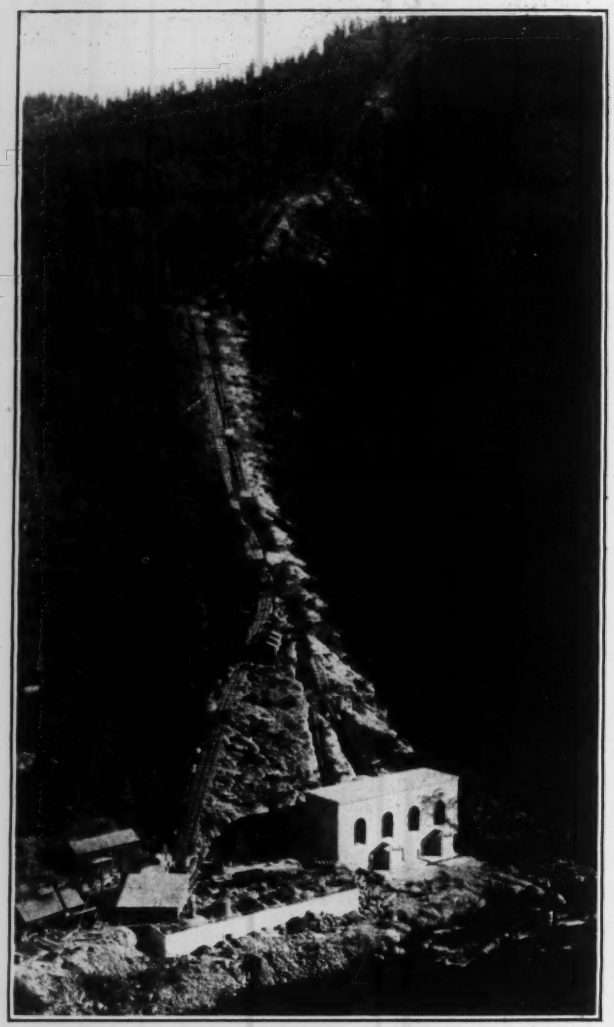
The penstock begins at the lower end of the surge chamber, having been run this far into the tunnel because the rock at the portal was disintegrated granite shot with seams of dirt. At the surge chamber the penstock is a triple-riveted lap joint pipe 80 in. in diameter and $\frac{3}{8}$ in. thick. It is solidly concreted in place to minimize danger of leakage, and its upper end is protected



PLAN AND DIAGRAMMATIC PROFILE OF PENSTOCK WITH DETAILS

by trash racks to catch débris that might come in through the tunnel or the surge chamber. Just inside the tunnel portal the 80-in. pipe terminates in a wye that branches into two 54-in. lines. The wye is bedded in concrete, which ends where the 54-in. pipes become parallel. Here there is a 60-in. butterfly valve in each penstock, the valves and accessory equipment being housed in a concrete building.

The two penstocks are each 4,800 ft. long, the static head at the upper end being 97 ft. and at the lower end



BUCKS CREEK POWER HOUSE AND PENSTOCK

2,561 ft. The upper 2,100 ft. is of triple-riveted, double-butt pipe in 24-ft. sections ranging in diameter from 54 to 42 in. and in thickness from $\frac{5}{8}$ to $1\frac{1}{4}$ in. The lower 2,700 ft. of the lines consist of banded pipe in 20-ft. sections with an inside diameter of 36 in. A total of 3,594 tons of steel was used in the penstocks and accessories. The lines parallel each other down the mountain 7 ft. apart, until at the last pitch they separate and enter the power house 56 ft. apart. In the power house a cast-steel wye splits each 36-in. line into two of 26-in. diameter serving the impulse wheel nozzles.

Back of each cast-steel wye a 26-in. connecting pipe joins the two lines through a spherical cast-steel tee on one penstock and a spherical cast-steel cross on the other. The cross has a blank flange cover for possible future extensions. The flow through the connecting pipe is to be controlled by a high-pressure gate valve 26 in. in diameter, the purpose of this connection being to economize water by utilizing both penstocks when one unit only is operating, thus cutting down friction losses and requiring less flow for a given output.

The flow of water is to be controlled mainly by governor-operated needle nozzles in the power house, although the 26-in. gate valves back of the nozzle are capable of closing against full flow. The butterfly valves at the top of the penstock are motor operated, arranged for remote control from the power house for closing only. A pressure-regulating device prevents opening the butterfly valves when the penstocks are empty, and with these valves closed the penstocks can be filled only by means of 12-in. bypass valves. The sluice gates at the entrance to the pressure tunnel are also motor operated by remote control from the power house.

The banded pipe consists of a steel core with a longitudinal hammer weld, on which are shrunk seamless steel bands of a predetermined inside diameter slightly less than the outer diameter of the core pipe. The width of each band is about 4 in., which is approximately equal to the space between bands. The thickness of the band and of the core pipe varies with the head, the maximum thickness of the core being about 1 in., which is the practical limit of efficient welding for the process used.

Banded Pipe Used

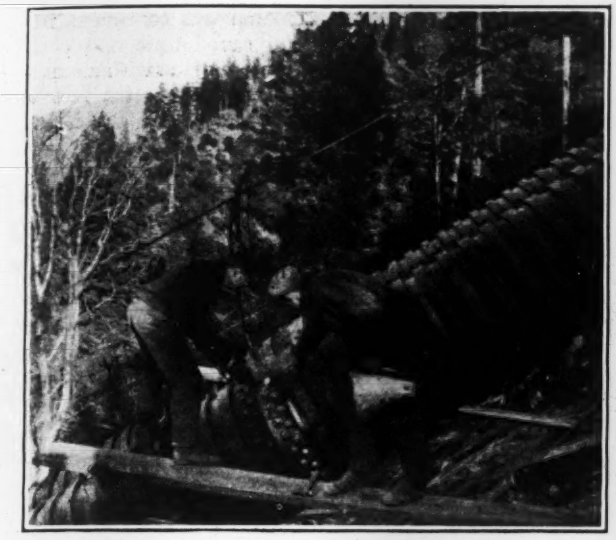
Penstock Design—The installed plant capacity is for two 20,000-kw. units, and in order to give as much assurance as possible against service interruptions due to causes originating in the penstocks it was decided to install two pipe lines instead of one. The maximum flow for full load is about 240 sec.-ft., or 120 sec.-ft. per pipe, with a maximum velocity of about 17 ft. per second.

The diameters were determined graphically by the usual method of least annual cost—that is, on the basis that the most economical penstock is that in which the sum of annual value of the power lost in friction plus annual charges for interest, depreciation, taxes, maintenance, etc., is a minimum. The graphical solution was found more flexible and more adaptable to the many variables that enter into the problem than were the mathematical formulas.

Two rules for determining pipe thickness were used, the one giving greater thickness to govern. These were: (1) stress in the pipe shell shall not exceed the elastic limit divided by 2.5 and (2) stress in the shell due to combined static and maximum water hammer heads shall not exceed 90 per cent of the elastic limit of the material. It was found that this provision for pressure rise had no effect on design for static heads exceeding 1,500 to 1,600 ft. but did increase the thickness of the riveted pipe in the upper portion of the penstock. A discussion of this subject appeared in *Engineering News-Record*, Oct. 7, 1926, p. 577.

Allowable stresses and factors of safety in the riveted pipe were as follows: 12,000 lb. per sq.in. in the net section under static conditions and 24,750 lb. per sq.in. under maximum water hammer. Boiler flange steel was used with a minimum ultimate strength of 55,000 to 60,000 lb. per square inch.

The banded pipe was designed by the manufacturer to conform to a factor of safety against bursting of 4.8 times the static head and not less than 2.5 times the static



MAKING A RIVETED JOINT IN THE BANDED PIPE

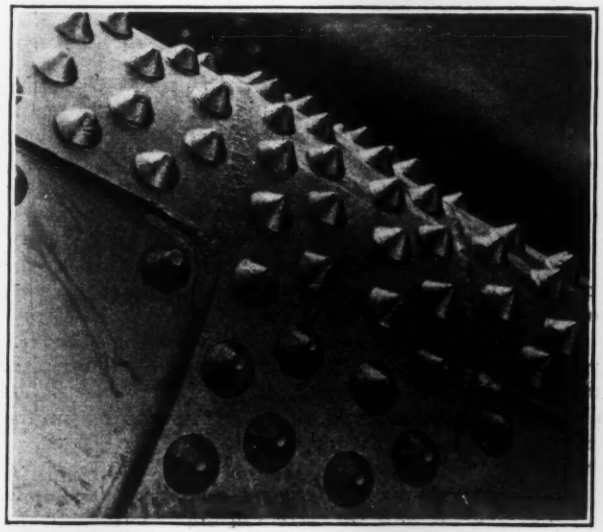
UNLOADING BANDED PIPE FROM INCLINE CAR

head plus maximum water hammer. The further restriction that the pipe should withstand a pressure up to 2.5 times the static head without permanent deformation was also imposed. The manufacturer used in the design empirical formulas based on a large number of pressure and bursting tests plus long experience. Theoretical formulas have been developed for the banded pipe but are not used because the empirical methods based on experiment are believed to be sure, safe and simple, whereas the slight deviations in the manufacturing process from assumptions made in the formulas give rise to serious differences in the results. This subject is a good field for further research.

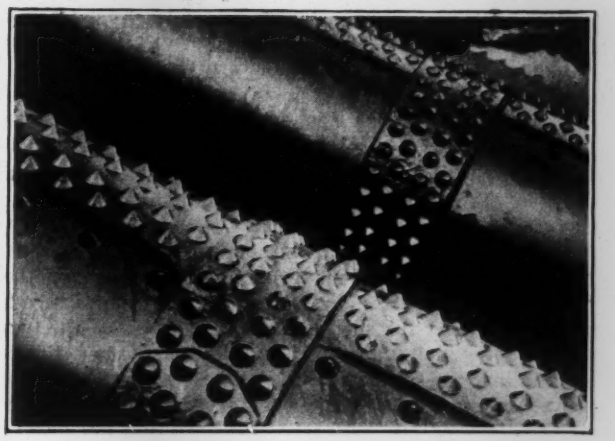
Prior to the acceptance of the manufacturer's design, seven full-sized sections were tested to failure, the pressures at yield point and at ultimate strength being recorded. These sections corresponded to the design for upper-middle and lower portions of the line. The results of the tests were satisfactory and proved that the design complied with the requirements. The type of failure was consistent. The inside diameter of the lighter sections expanded from 36 to 40 in. before failure. It was noted that failure occurred in the core pipe between the bands in the form of a longitudinal crack of small area. The bands did not fail, thereby restricting the opening. In one instance the core opened up in a longitudinal crack from one end to the other, but, as in the other specimens, the area was not large. Failure of this sort would involve the minimum danger of a penstock washout should a bursting failure occur on a penstock in service—something that has never happened yet with banded pipe.

The material used in the core pipe was Siemens-Martin open-hearth steel with an ultimate strength of 48,000 to 58,000 lb. per sq.in. and a minimum elongation of 25 per cent. The material for the seamless bands has an ultimate strength of 64,000 to 85,000 lb. per sq.in., a minimum elastic limit of 37,000 lb. per sq.in. and a minimum elongation of 18 per cent. Nickel steel was used in the bolts.

Two 30-in. standpipes 125 ft. high are located at the top of the penstock near anchor 1. These vents, which are trussed together and guyed, are connected to the penstocks by means of goosenecks. Further provision for preventing collapse in the event of a sudden release of water from the pipe is provided by two nests of three 6-in. air valves in the upper portion of each line. Bends in the riveted pipe were made in the usual manner with



THE WELDED JOINT IN RIVETED PIPE



THE SCARFED JOINT IN RIVETED PIPE

segmental sections and butt straps. Flanged cast-steel bends were used throughout the banded portion.

Expansion joints in the banded pipe consist of a cast-steel housing with a packing gland for square hemp packing and a copper-plated seamless steel insert with shrunk-on cast-steel flange. The joint is provided with six large staybolts, which permit movement of the pipe but do not allow the joint to be pulled apart. One of the features of the flanged joints that is also used on the other specials is a calking groove on the inside, which, in case of leaks, may be filled with babbitt or other soft metal and peaned in place.

Manholes are provided at approximately 500-ft. intervals on each pipe. In the banded portion the manholes are in the expansion joint housings. An electrical recording pitot tube set installed in upper portion of each pipe for measuring the flow is arranged to record on a chart in the power house.

Each section of banded pipe was tested in the shop to 175 per cent of the static head, or a pressure equal to static plus maximum water hammer, whichever was greater for the section. Five sections only of the riveted pipe were tested to a pressure not exceeding 75 per cent of the elastic limit of the material. All steel castings and specials were tested at 200 per cent of the static head. All of these tests showed satisfactory workmanship and material. Prior to acceptance the entire penstock as assembled in the field was to be filled and tested and any leaks calked.

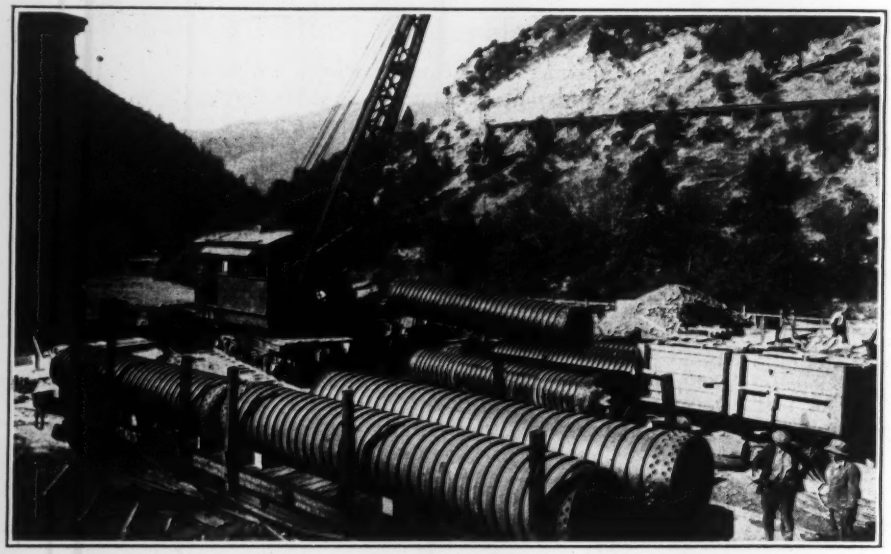
Field Methods — Field joints on riveted pipe at first followed the usual design for triple-riveted, double-butt pipe, which consists of an outside roundabout, double shop riveted on one side and two rows of field rivets on the others. This strip passes over the end of the outside longitudinal strap, which is scarfed down to a thin edge. Fabrication and erection commenced at the lower end, where the diameter is 42 in. and the plate thickness $1\frac{1}{4}$ in.

At first the field joints were fitted up in the field, and the erection crew had great difficulty in getting the roundabout strap down close over the heavy longitudinal strap. Heating with torches and then sledging the roundabout into shape delayed erection so much that fitting field joints in the shop prior to shipment was tried. This was better, but still, because of the heavy metal in the joint, the time lost in the field and the cost of getting a good job were too great.

It was then decided that the longitudinal strap should be cut off squarely about $\frac{1}{8}$ in. from the edge of the roundabout strap, thus eliminating the scarf and, instead, welding together the shell and adjacent edges of the two plates. This plan, which solidly filled the space between longitudinal and roundabout with welding material, proved satisfactory in every way, speeded up production and not only greatly facilitated field erection but gave a neater and tighter joint. Even after this the practice of fitting up field joints in the shop was continued, because it gave a better job and saved time and cost.

Field joints in the banded pipe were made with a seamless butt strap, double riveted in the shop to the female end. The male end is slightly tapered and the inside of the butt band was machined to fit. Each joint was then fitted together in the shop and the holes were drilled through both strap and core at the same time, thus insuring a perfect alignment and eliminating unfair holes. Each joint was marked so that field assembly would be the same as in the shop. All castings and specials were flanged and bolted, gasket and groove being provided in each case.

Although the ridge on which the penstock is located is apparently not subject to slides, being steep enough to drain well into the adjacent ravines and having loose material that is for the most part disintegrated granite, nevertheless the foundation presented difficulties because of the depth of bedrock in many places. Where practicable, of course, foundations were carried to rock; otherwise footings were spread. On rock foundations maximum toe pressures up to 17,200 lb. per sq.ft. were used, on decomposed granite between 4,000 and 5,000 lb. per sq.ft. and on soil and boulders 2,600 lb. per sq.ft. The minimum depth below ground was set at 11 ft. and the maximum depth 33 ft., except in a portion of No. 2 anchor, which was carried down to rock at a depth of 41 ft. to get uniform, solid bearing.



UNLOADING BANDED PIPE AT BOTTOM OF INCLINE

All piers and anchors are of the gravity type. To provide one support for each pipe section, piers are spaced 24 ft. on the slope for riveted pipe and 20 ft. for banded pipe. Piers are so placed that each pipe section is supported at the upstream quarter point, this being the most convenient position for the erection crew. Each pier under banded pipe is provided with a pair of steel friction plates curved to fit the pipe and with the lower plate anchored into the concrete.

A total of 10,350 cu.yd. of concrete was taken up the incline and delivered to anchors and piers, 6,900 cu.yd. being put in the former and 3,450 cu.yd. in the latter. The concrete was mixed at the power house, hauled up in a specially built bottom dump car of 5-cu.yd. capacity and chuted into place. By this method concrete was placed

at top of the incline ten to fifteen minutes after mixing. The largest anchor contains about 840 cu.yd. of concrete.

Delays in the arrival of the foreign pipe, particularly the expansion joints, made it impossible to lay the line continuously, and erection was therefore carried on intermittently at various points according to the order in which sections arrived. A section embedded in an anchor was always used as the starting point for erection, work advancing uphill from this beginning. On the banded pipe a "Dutchman" located above each bend made it possible to correct any small variations in alignment with the minimum of trouble.

After being transported by the car on the incline to the desired point along the penstock, sections were delivered to position in the trench by either one of two methods. The first method, used on all of the riveted pipe and part of the banded pipe, was to lift the section from the incline car and swing it into place in the trench with a stiff-leg derrick operated by a gasoline engine skidded up the penstock line from pier to pier ahead of the pipe-laying operation.

The other method also involved the use of a gasoline engine operating a winch moved up the line of piers ahead of laying operations, the difference being that in the second case, after the pipe section had been secured by fastening a cable from its upper end to a suitable anchor point up the line, the section was rolled off the incline car to its place in the trench.

In all of the piers and anchors the first concrete pour was discontinued at a level 6 to 20 in. below the bottom of the pipe. After jacking a section to exact grade and alignment, a cribbing of scrap railroad iron was built up under it and wedged firmly in place on each pier or anchor to carry the weight temporarily. A large quantity of scrap rail was purchased for this purpose in 40- to 60-lb. sizes and cut with a torch into 1-ft. lengths. The cribbing was left in place, of course, when the second concrete pour was made to bring pier or anchor up to final height. After trying other schemes, the most practicable method of lining up sections was found to consist in marking the exact center line on each pier.

Protective Coating for Pipes

The banded pipe was given two shop coats inside and out of an asphaltic paint of excellent quality, applied hot. It survived well the rough handling during transportation from Europe to its place in the line. Prior to acceptance all scratched or marred places were to receive a final field coat of the same paint.

The riveted pipe was sand blasted to the bare metal and received two shop coats inside and one coat outside of asphaltic paint. A complete second outside coat was to be applied after erection.

The entire Bucks Creek development, including penstock and piers, is being built for the Feather River Power Company under a contract with R. C. Storrie & Company, general contractors. The Western Pipe & Steel Company fabricated the riveted steel portion of the penstock and erected the entire line, having purchased the banded pipe, specials and expansion joints from the Ferrum Company, of Poland. Engineering work for the Feather River Power Company was done by the Constant Angle Arch Dam Company, Lars Jorgensen, chief engineer; Ross White, resident engineer in charge of construction; C. W. Faries, office engineer. W. A. Brackenridge is engineer for the underwriters, the First Securities Company of Los Angeles.

Interpretations of the Code of Ethics

Two interpretations of the code of practice of the American Society of Civil Engineers were acted upon by the board of directors at its meeting held just previous to the recent annual meeting. In view of their importance, the findings are given herewith, together with the questions submitted to the committee.

Question No. 1.—An engineer, A, a corporate member of the American Society of Civil Engineers, employed as a divisional engineer by a national trade organization, sends out to engineers and purchasers of certain material, use of which is promoted by the said trade organization, engineering studies of the service of a competitive material. These reports on results and failures under certain conditions of a competitive material are sent out in pamphlet form accompanied by a letter from A on stationery bearing the name of A as a civil engineer. Neither the letterhead nor the pamphlet describing the investigation indicates in any way the connection of A with the said trade association. The truth of the findings of A as to the competitive material under the conditions and in the case investigated are not here questioned, but the information as sent out is calculated to convey the impression of an independent and disinterested engineering investigation of the competitive material by the engineer A as an independent practitioner. A ruling on the propriety of the action described is requested.

Answer.—The committee on professional conduct is of the opinion that Engineer A has directly violated the code of practice of the American Society of Civil Engineers, particularly paragraphs 4 and 5 of Part II:

> 4. He shall not directly or indirectly engage in any of the building trades while practicing professionally
>
> 5. He shall inform the owner of any business connections, interests or circumstances which might influence his judgment or the quality of his services.

In the opinion of the committee, Engineer A has, by sending out engineering studies of the service of a competitive material without disclosing his own employment by a competitor, given the impression of being a disinterested practicing engineer. While not necessarily employed by an owner, as specified in paragraph 5, above quoted, he has by indirection sought to convey an impression to prospective owners other than that which would have been conveyed had his connection with a trade organization been disclosed.

Question No. 2.—(1) Engineer A was employed as consulting engineer by a contracting firm having a contract for the construction of a dam for a municipality, receiving a monthly retainer and also in addition a per diem where special services were rendered. Is it permissible, under the ethics of the American Society of Civil Engineers, for such consulting engineer to accept employment from the municipality as an expert to pass and make report upon the integrity of the work performed by the contractor as a preliminary to the final acceptance of the work by the municipality from the contractor?

(2) Engineer B was employed as consulting engineer by a contracting firm, having a sub-contract under a general contractor, for the construction of a dam for a municipality, receiving a monthly retainer and also additional fees for special services performed. Is it ethical, according to the standards prescribed by the American Society of Civil Engineers, for engineer B to accept employment from the municipality as an expert to pass upon the integrity of the work performed by the contractor as a preliminary to the final acceptance of the work from the contractor by the municipality?

Answer.—It is the opinion of the committee on professional conduct that neither Engineer A nor Engineer B should accept employment from the municipality to serve as an expert to pass upon the integrity of the work performed by the contractor as a preliminary to the final acceptance of the work by the municipality from the contractor. Either engineer is, in fact, an agent of the contractor and for this reason his service in behalf of the municipality to review the work of his own principal is not in accord with the spirit of section 1 of the code of ethics.

Contracting Business Hazards and Reforms Reviewed

Associated General Contractors' Committees Report on Day Labor, Credit Practices, Surety Bonding, Licensing, Insurance, Lien Laws, Accident Prevention, Quantity Survey and Cost Keeping

WITH an engineering construction business amounting to seven billions a year, rational practices in contracting procedure and in the manufacturing and vending of equipment and materials used in construction deeply concern all engineers. Criticism of these practices is general. It is claimed that loose sales and credit practices are common among venders who fall back on the lien laws and the surety bonds for protection. It is pointed out that contractors' cost-keeping methods are poor, particularly in respect to overhead and plant depreciation and plant rental charges. It is stated that liability insurance rates are mounting because of lack of attention to accident prevention in construction. As the result of these and other causes it is asserted that irresponsible contracting is being widely inducted into construction. These are the claims and contentions.

In the series of committee reports presented at the annual convention of the Associated General Contractors, West Baden, Ind., Jan. 23-27, 1928, which are abstracted herewith, the conditions are rehearsed and the growing activities of the association to improve them are outlined. The outstanding facts to be observed are that the work has been persevering and that progress is being made. Slow progress until now is frankly admitted. The battle has been against intrenched customs and ancient prejudices. It has taken a long time to overcome the inertia of habit. In some cases it has hardly been disturbed. In other cases motion has been induced and acceleration has only to be maintained. The beginning of 1928 finds organized contracting well started on its work to create general quantity surveys, to liberalize contracts, to curb day labor, to reduce accidents and to improve corporate surety bonding. It finds attention being directed to lien law liberalization, to the correction of loose credit practices, to better subcontracting practices, to improved business ethics and to better cost-finding methods.

This progress calls for support and co-operation by professional engineering.—EDITOR.

Day Labor, Lien Laws and Licensing Contractors

BY GEORGE B. WALBRIDGE
Chairman, Committee on Legislation, Detroit, Mich.

OUTSTANDING legislation that concerns general contracting in a broad national way includes the federal day-labor bill, standard lien laws, the harbor workers' compensation act and licensing contractors.

Federal Day-Labor Law—Modified along lines suggested by the House judiciary committee, before which the Campbell day-labor bill, sponsored by the association, went last year for a hearing, the act relating to federal construction by force account has been reintroduced at the present session of Congress. The new act provides that for government construction exceeding $25,000 in cost and not constituting maintenance and repair, the federal agency undertaking the work shall prepare complete plans and specifications and detailed estimates of costs. Then competitive bids shall be asked. If the bids be reasonable as judged by the federal agency, the construction shall be let to the lowest responsible bidder. If the bids are held unreasonable, the federal agency may do the work by day labor or any other method.

It is required that the estimate of cost shall include fair and reasonable charges for construction equipment and all other costs, whether paid directly from the specific appropriation for the work or from other funds and whether paid by the agency in charge of the work or by some other agency. Also it is provided that the estimate of cost shall be read and shall become public record at the time the bids are opened. When the work is done by force account, within 60 days after completion there shall be compiled a statement of the total expense, together with a detailed statement of any change made in the plans, specifications and time of completion.

Standard State Lien Law—In respect to lien laws, the association's action has been concerned chiefly with the work of the Department of Commerce committee, of which the A.G.C. is a member, in drafting a standard state mechanics' lien law. The committee's first tentative draft for such a law was opposed by the association as too drastic in the obligations placed upon owners to provide protection of certain interests. In July, 1927, a second draft was issued, which is considered to be even more drastic than the first and which is opposed by the A.G.C. and the American Engineering Council members on the committee. The particular features of the second draft to which the A.G.C. takes exception are:

The contractor is required to give a sworn statement in connection with every progress payment, showing all unpaid accounts for labor, materials and service. The owner must then withhold from the progress payments sufficient money to pay all outstanding accounts, unless the contractor presents waivers of liens covering these amounts. The owner, in the absence of these waivers, may pay the money direct to sub-contractor and dealers. If the owner fails to comply with this requirement, or in other words fails to act as the disbursing officer and to do it properly, he may become liable for dual payment.

No dealer or sub-contractor doing business with the general contractor is required to give the owner notice to withhold money or that he is liable under the law for unpaid accounts, which obviously places the average owner in a very insecure position.

In considering these provisions of the proposed lien law, the association's committee on legislation feels that they go far beyond any requirements for protection against unpaid accounts. The attitude of those in the Department of Commerce committee favoring the provisions is freely stated. They desire 100 per cent protection for every sale that a material man could possibly make, irrespective of his purchaser's responsibility, and they do not want to give notice to the owner because of the hazard of incurring the contractor's ill will. So far they have been able to carry their point.

Harbor Workers' Compensation Law—This federal law, becoming effective July 1, 1927, to govern compensation for injury of workmen engaged in maritime employment has raised the question whether it governed in case of contractors' workmen engaged in construction on navigable rivers and on structures along the water front or whether the state workman's compensation law governed. The essence of the measure is that it shall apply to those men who are engaged in the work of water transportation and not to persons engaged in constructing the permanent facilities by which that transportation is carried on. This has been the general

tenor of the decisions rendered by the U. S. Employees' Compensation Commission, the function of which is to give opinion or jurisdiction in specific cases.

Contractors' License Laws—Agitation for laws licensing contractors has been active in the Southern states. North Carolina has such a law, and the contractors of that state believe it has been a benefit. A similar bill was introduced in South Carolina, but the Legislature radically changed its intent and purpose. Georgia has a license bill in its Legislature, but it had not been passed as of Jan. 15. Such a bill was introduced in Alabama at the last session, 1926-27, but was sidetracked by other business. A bill is before the Florida Legislature and is considered to have a good chance of becoming a law. In New Jersey a licensing act failed in 1926 and is to be reintroduced. The A.G.C. has expressed approval of licensing, but believes its promotion is the business of state associations and not that of the national organization.

* * *

Quantity-Survey Movement Is Growing Rapidly

By Alex Simpson, Jr.
Chairman, Committee on Quantity Survey, Denver, Colo.

EXPERIENCE with quantity survey during 1927 has brought conviction that this service has come to stay. During the year group quantity survey was adopted by the North Carolina, Philadelphia, Boston and Hartford chapters. Time has tried and proved the value of the quantity-survey bureaus operated by the Texas branch and by the chapters in Detroit, Milwaukee, St. Louis, Birmingham, Memphis and Portland, Ore. Some of the commercial quantity-survey bureaus are performing a desirable service to contractors, but others employ practices that merit severe condemnation. Of these practices that of affixing prices to the quantities is particularly vicious. The committee urges as a remedy the formation of group quantity-survey bureaus by contractors themselves. There is ample experience now to determine the success of such action.

* * *

Contractors Adopting Accident Prevention Practices

By W. F. Austin
Chairman, Committee on Accident Prevention, Cleveland, Ohio

ACCIDENT prevention work is gaining favor among contractors. The association's educational work in accident prevention has greatly increased. The W. E. Wood memorial fund for advancing safety education has grown to $19,300. An accident prevention manual has been published by the association, and during the year the association has had a full-time safety engineer in the field inaugurating accident prevention work among individual contractors and association chapters. A series of accident prevention signs have been proposed. Three cups have been donated to be awarded for the best records in accident prevention.

Extension of accident prevention to highway construction has been well begun. Arrangements have been completed with the Massachusetts Department of Labor to establish a safety division and are now in progress with the Ohio Industrial Commission. The Detroit, Milwaukee and Texas chapters have group accident prevention in full operation. The Louisville chapter has inaugurated the work and the Associated Pennsylvania Constructors has undertaken accident prevention in combination with group insurance. During the year the association's safety engineer has worked in seventeen states and forty cities, advocating and inaugurating accident prevention measures.

The belief is that mandatory legislation in most cases is not the most desirable means of accident prevention. Rather, the committee has agreed upon making an effort through conferences between the association's safety engineer and state industrial commissioners to arrange for co-operative work. Many of the state officials feel, with the association committee, that it is easier to accomplish desired results by a movement within the industry than through the passage of laws with flexible provisions. Although safety laws are desirable from one point of view, the difficulty with them is in drafting one that will prevent rather than merely penalize accidents. The attitude of the committee is based on the idea that accidents are primarily the result of recklessness and ignorance on the part of the working force, a condition that can be corrected only by safety education, protection from hazards, supervision and good housekeeping on the job.

* * *

Advance Made in Mixer Standardization

By Lion Gardner
President, Mixer Manufacturers Bureau of the A.G.C., Cleveland, Ohio

DURING 1927 nine state highway departments adopted in their specifications clauses specifically requiring the use of standard mixers. In general these clauses specify that the volume of mixed material in each batch shall not exceed the A.G.C. rated capacity of the mixer used. There are now sixteen manufacturers in the bureau. During the year two manufacturers joined the bureau and one manufacturer was expelled for non-compliance with its standards. It is estimated that the sixteen companies control the production of 90 to 95 per cent of the construction mixers and 100 per cent of the paving mixers.

No changes in mixer standards were made in 1927 and none of major import is now contemplated. Further data on water requirements for the various proportions of mix with various slumps are being sought by the bureau with the object of increasing if possible the accuracy of water tanks and measuring devices. The assistance of the research section of the Portland Cement Association has been obtained and the subject is now receiving extensive investigation by the bureau's technical committee, which consists of the chief engineers of five member companies. The relation of drum capacity to rating is being studied by a special committee with a view to working out ultimately ratios that may be used in advanced drum design. The work is being carried on in two parts, one being the study of ratios for the tilting and non-tilting types of drums with two openings and the other for the single-opening tilting type.

Incidentally it may be stated that the technical committee of the bureau is available to contractors, state highway engineers, city officials and any others who may desire investigations, research or counsel in matters pertaining to concrete mixer performance. This service is rendered without charge.

* * *

Cost Accounting and Depreciation Studies Are Important

By D. B. Fegles
Chairman, Committee on Methods, Minneapolis, Minn.

IT IS urged that cost accounting and estimating be made a major subject in the A.G.C. local organizations. During 1927 a special committee worked with the Internal Revenue Bureau (1) to establish in the income tax unit and in the contracting business a rational conception of equipment expense and (2) to establish standard practices in checking tax returns to eliminate most of the disputed cases that have arisen in the past. Five methods of depreciation have been tentatively adopted. Some of the details of these methods need to be worked out and agreed upon, and when this is done the committee expects to prepare jointly with the bureau a complete set of standard instructions.

Although it is generally conceded that inferior estimating and accounting practices exist in all branches of contracting, it has been difficult to interest local chapters in promoting rational methods. It is recommended that every branch and chapter undertake this year:

1. To provide the chapter secretary with whatever assistance he may need for gathering and tabulating cost data for members.

2. To induce those members who keep rational cost records to allow the secretary or an accountant to study them and to tabulate the various items.

3. To compile an analysis or summary of costs from these

tabulations in such form that it may be studied by the group.

4. To hold a series of estimating and cost-accounting meetings to study the summary and derive some conclusion as to what is a reasonable cost for the various items of work under the average condition—particularly equipment costs and overhead.

5. To place the final conclusions reached in the hands of every member or any other legitimate contractor in the community. Should the chapter be composed of municipal or highway contractors, to take the officials concerned into confidence and acquaint them with the results of the study.

6. To develop a live committee of members' accountants and help any interested contractor in the community, whether a member or not, to install a good system of estimating and accounting.

The national association has not developed a standard system of estimating and accounting, but it has developed estimating sheets for highways and buildings, equipment-rental schedules and numerous other records and forms that can be used as a basis for formulating such a system. At present the Illinois branch, the Cincinnati chapter and the Northwest branch have such systems in operation. The downward trend of prices so generally complained of will continue until construction companies as a whole adopt rational methods of estimating and cost accounting.

* * *

Surety Bonding Situation Has Improved

By F. L. Cranford
Chairman, Committee on Insurance and Bonds, Brooklyn, N. Y.

THE discussions and conferences that have taken place during the last five years with respect to surety bonds have not produced the desired reforms in practice, but it cannot be said that the efforts put into them have been wasted. They have succeeded in bringing to light certain conditions that for years have been ignored and have crystallized the conviction that some plan for improvement must be evolved. The various conferences have also brought into unanimity of opinion the various groups that take part in construction, including engineers, architects, public officials and to some degree the surety companies themselves. In conference these groups have discovered the needs of construction with respect to both bonding and awarding practices and have declared those things that should underlie any plan of improvement. Finally, they have informed the public of four very important facts:

1. The corporate surety bond gives credit to the person bonded and should be surrounded by the usual safeguards employed in credit transactions.

2. Such bonds are not the kind of a guarantee that the public assumes them to be, in that they do not indicate responsibility in a bidder and do not protect the owner against all the loss occasioned by default.

3. The surety bond, under existing practices, is one of the main causes of overexpansion of construction companies, both large and small, and it is this overexpansion that is undermining the contracting business.

4. The basic need of the construction business and of its allied industries is a tightening up of automatic credit, particularly in the case of those who are inherently irresponsible.

Although it has taken a long time for these conceptions to develop, it now appears that they are widely enough recognized to promise a practical plan for improving the bond situation. Of the several plans proposed none has met the situation. One has to be developed and now the Surety Association has agreed to sit jointly on a committee of engineers, architects and contractors to undertake the task. It appears now that the present year will witness the beginning of intelligent co-operation between the surety business and the construction industry.

During the past year liability insurance rates in many parts of the country have taken a decidedly upward trend. The increase is especially great in those states that do not have workmen's compensation laws. Coincidental with this tendency have come criticisms from state industrial commissions that the frequency and severity of accidents in construction are too high, which few members of the A.G.C. will deny. It is stated by the insurance companies that construction rates are high not because the companies are seeking unwarranted profits but because they have better statistics and know where the losses occur. We have no evidence to indicate that the statement is not true. Insurance rates are more or less a matter of arithmetic, and the only way they can be made lower is by reducing the number of accidents.

Contracting in many parts of the country is confronted with a defensive struggle against impossible safety codes proposed by well-meaning but uninformed persons, and the only apparent means of avoiding the ruinous effects of such codes is through accident prevention. Group safety measures under a proper plan mean a saving of life, cash in the pockets of contractors, money to their local associations and a considerable reduction in their construction costs. Fairly accurate figures indicate that the direct monetary loss from accidents is only about one-third of the contractor's total loss.

* * *

Materials and Equipment Sales Practices Are Bad

By J. T. Pardy
Chairman, Committee on Materials and Equipment, Bridgeport, Conn.

PARTICULAR effort should be made by the association to improve sales and credit practices in merchandising both construction equipment and materials. Investigation shows that hazardous credits are common. Apparently the manufacturerer's and the producer's pressing need to place their ouput has caused them to become careless. The result is demoralizing the construction business. At the same time that reckless selling and credits are practiced an effort is being made to make the lien laws more drastic to avoid the results of these practices.

Credit associations and cash discount agreements for prompt payment are remedies that are being tried with promise of success in New York City and in Illinois. The committee makes no recommendation with respect to credit bureaus but suggests (1) that credit bureaus of the mercantile trades do not seem able to serve the needs of construction, (2) that American business of all kinds has found that credit bureaus are a necessity and (3) that those industries that seem most prosperous have good credit bureaus.

* * *

Loose Credits Hamper Progress in Construction

By J. Charles Wilson
Chairman, Committee on Construction Development, Pittsburgh, Pa.

VIEWED from the angle of volume alone, the construction industry has witnessed a period of unprecedented prosperity, but at present it is a prosperity that contains much cause for apprehension by contractors. One of the greatest hazards is the growth of loose credit. Selling procedure in the plant and material fields has reached a point where almost anyone, without organization, equipment or experience, can find equipment and materials at his command merely by signifying his intention of entering the contracting business. Even the banker gives overgenerous credit. The committee offers the following suggestions for dealing with the problem of loose credits:

1. Promote universal use of the standard questionnaire and financial statements and make known generally to public officials and the public that the awarding official is required by law to ascertain the responsibility of bidders.

2. Place the standard questionnaire in the hands of bankers and show them how to investigate the responsibility of a construction company.

3. Exert an effort to have the same questionnaire used by the surety, in order that a three-way check may be established on the qualifications of any bidder.

4. Inaugurate co-operative work with responsible material and equipment interests to bring about a reasonable tightening up of credit policies in their business.

The final suggestion may seem vague and impossible, but the progress already made by some local associations indicates that it probably offers the greatest field for tangible accomplishment. As an example, the procedure of one local will be:

1. The association agrees to discount all bills of its members or any other contractor desiring to use its service.
2. The discount is a sizable one and reverts one-half to the individual contractor and one-half to the association revolving fund.
3. The materials dealer is paid by the association and assigns his account to the association, which presents it to the highway department and receives a sufficient part of the contractor's estimate to pay his indebtedness.

This arrangement has the backing of the local association members, the manufacturers of equipment and materials and the state highway department and will be in operation this year.

Drained Paving Used to Stabilize Road on Sliding Side Hill

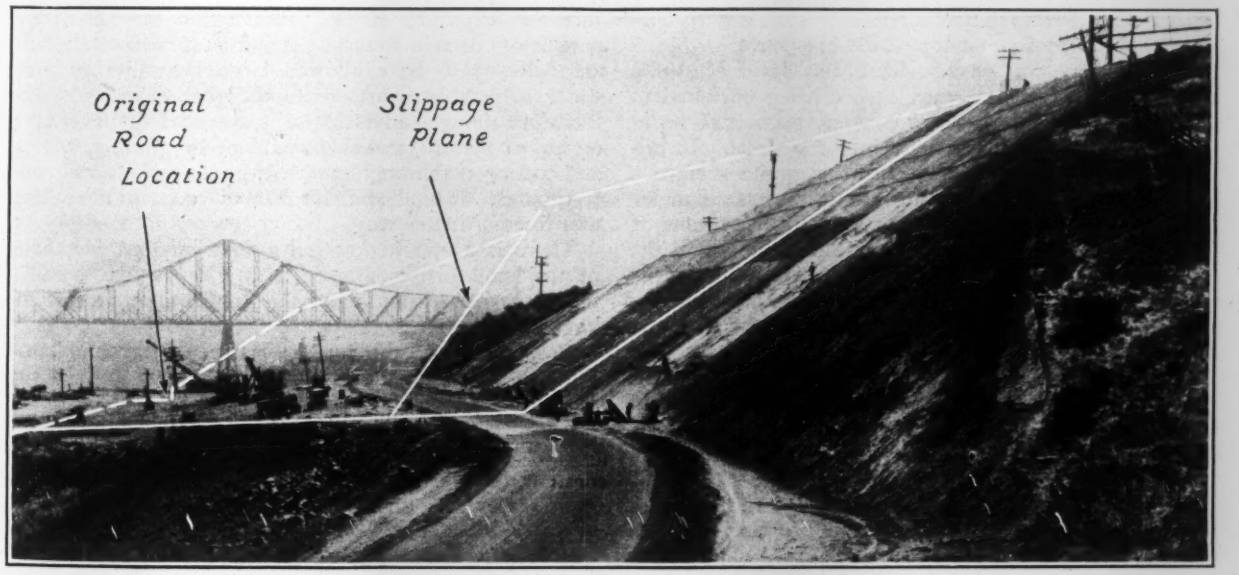
After Ten Years of Slipping, Deep Bench Cut on California Highway Is Held by Novel Method of Keeping Bank Dry

A SHORT stretch of state highway on side-hill location near the town of Crockett, Calif., has given trouble almost continuously over a period of years due to a tendency in the slope to move down not only upon the road itself but also upon the railroad at the foot of the hillside some 700 ft. horizontally from the road center line and about 200 ft. lower in elevation. The railroad company and the California Highway Commission combined to fight the slide. However, although the length of road involved was only about 250 ft. and numerous remedial measures were applied, slides continued to menace highway and railroad until the extensive reconstruction project here described was begun.

The reconstruction scheme, believed to solve the problem, has included (1) the excavation of about 116,000 cu.yd. from above the roadway which was considered as a surcharge on the slope above the slippage plane; (2) drainage and paving of the slope of the bench cut, 57 ft. deep at roadway center line; and (3) an oiled waterproof surfacing of some 200,000 sq.ft. on the top of the hill, 120 ft. above road level. The effectiveness of these recently completed protective measures is enhanced, of course, by work done in previous years on a series of drainage tunnels below the road, a piling toe wall, etc.

In 1921, working under an agreement between the railroad company and the highway commission for a cost-sharing basis of combating certain conditions in the slide, both organizations began a determined campaign to control it. After purchasing an eight-acre area over which the slide extended, so that stabilization work could be carried on without interruption, the railroad drove about 1,130 ft. of 4x6-ft. main tunnel and laid 260 ft. of 8-in., 630 ft. of 6-in. and 240 ft. of 4-in. drain pipe to carry off surface water. To facilitate runoff and to prevent penetration of rain and surface water generally, a considerable area of the slide was also smoothed over and a coating of heavy oil was applied. At the foot of the slide, just above the tracks and where the earth pressure was greatest, a pile grillage was constructed with 191 piles on 8-ft. centers, heavily braced and strutted, the upper rows being curved against the slope. The drain tunnels proved effective to the extent that water flowed from them at all times, even during the driest periods of the year. During one two-day storm the discharge from the tunnel and piping system was at the rate of 8,600 gal. per hour.

Although highway commission forces also did much remedial work in the early history of the slide, the slipping continued, and to maintain the road timber bents were put in that virtually carried the roadway across the slide on a trestle. In 1926 the reconstruction program of the highway commission, based on increased traffic over this route, called for a roadway at least 34 ft. wide across the slide, which was still a menace to even the narrow roadway then existing. Surveys, a geologist's report and diamond-drill borings to a depth of several hundred feet, combined with previous experience at the site, all led to the conclusion that the continued sliding



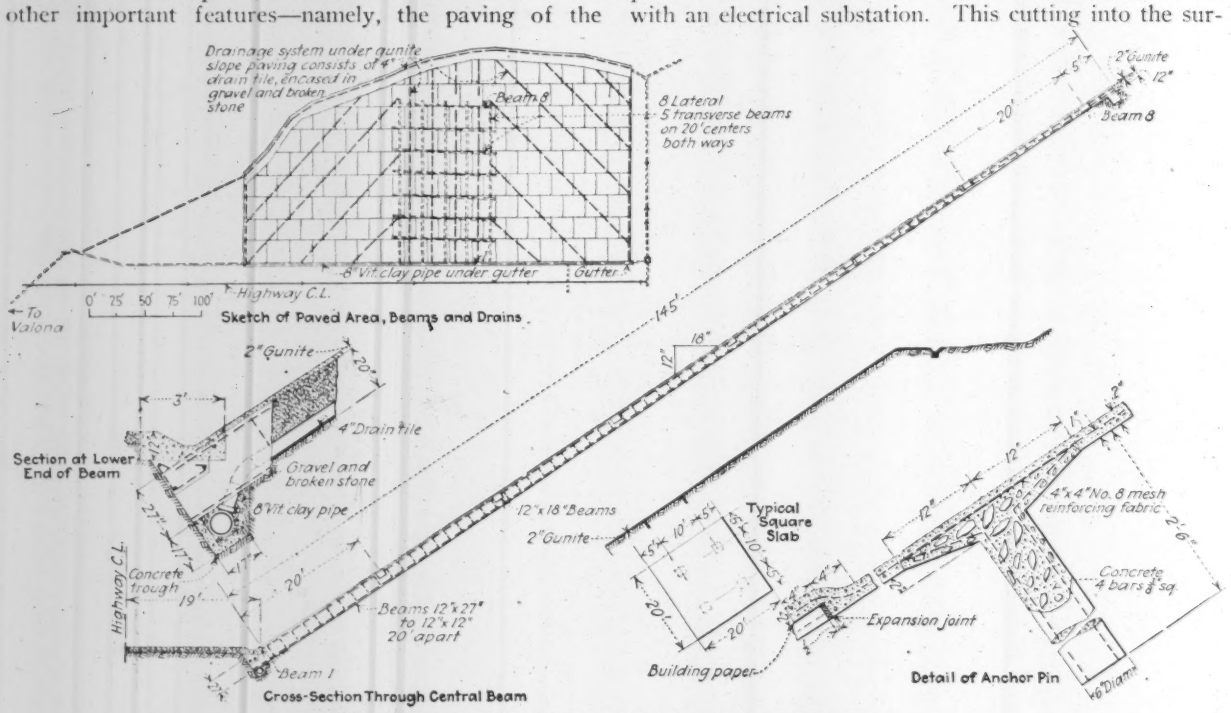
THE DEEP BENCH CUT WITH PAVING NEARING COMPLETION
Dotted line shows surface before reconstruction. Base of transmission tower at upper right-hand corner is 100 ft. above roadway. Hilltop behind tower was waterproofed.

was due principally to the presence of water in a seam or contact plane between two formations. It developed that by making a heavy bench cut and removing some 86,000 cu.yd. of material from above the roadway, a roadbed could be located on the stable side of the main slippage plane, leaving a 1½-to-1 slope between the road and the crest of the hill. This plan of construction was accordingly adopted.

By excavating this large yardage from immediately above the roadway, a considerable loading or surcharge on the slipping plane was removed and this material was hauled beyond the zone of influence of the slide. In addition to the deep cut, remedial measures included two other important features—namely, the paving of the cast bituminous strip put in each joint with the forms. The entire under-surface of the paving was drained by a system of 4-in. tile drains leading down to an 8-in. drain below the roadway gutter.

The maximum width of the paving as measured up the slope is 182 ft. and the length is about 341 ft., the total area involved being about 45,000 sq.ft. The paved surface was cured by covering the entire area with burlap, which was kept wet by sprinkling for four days.

The top of the hill was originally a rounded knoll reaching an elevation about 130 ft. above the roadway. Some years ago the cap of the knoll was graded off to provide a level area of 400x500 ft. needed in connection with an electrical substation. This cutting into the sur-



SECTION AND DETAILS OF PAVING ON THE CUT SLOPE

1½-to-1 slope above the new roadbed and the waterproofing of the flat surface on top of the hill above.

The cut slope was paved with a 2-in. layer of gunite placed in 20-ft. squares, each square being anchored to the hillside by four dowels or concrete anchors, 6 in. in diameter and extending 30 in. into the slope. In addition to the dowels that support the gunite surface a grillage of reinforced-concrete beams was placed under the central portion of the paving as a further means of supporting the slope against a local land slip within the paved area. This beam grillage, it is believed, provides the maximum protection against a slip immediately under the transmission tower at the top of the slope that carries one end of a 4,753-ft. span of 165,000-volt conductors. The beams vary in depth from 1 ft. near the top of the slope to 27 in. at the bottom, and extend about 100 ft. along the road, both lateral and transverse spacing being 20 ft. They were poured in trenches excavated in the finished slope of the cut.

Concrete in the anchors was poured before the facing was put on, of course, and anchor reinforcing was tied into the wire mesh used on the slope as a whole. The paving itself was shot on in the 20-ft. squares after construction joints had been laid on all four sides of each square. These joints were made impervious by a pre-

face and exposure of the strata within the hill to the percolation of rain water collecting on a horizontal plane are believed to have allowed large quantities of rain water to percolate through to the slide below. It was therefore thought advisable to waterproof the level area on top of the hill, and this was done by grading, rolling and coating it thoroughly with E-grade asphalt and rock screenings. A total of about 200,000 sq.ft. on the hilltop was treated in this way.

There is a still higher hill a few hundred feet back of the knoll just mentioned, and it is thought possible that deep percolation from this higher elevation might have an effect on the slide. There is, however, a saddle or lower level of the surface between the round knoll already referred to and this higher land and in the saddle it is proposed to put a trench, 40 ft. deep or more if feasible, should it later be thought probable that seepage from the higher level must be diverted.

Remedial work for the Southern Pacific Railroad has been under the direction of W. H. Kirkbride, chief engineer, maintenance of way and structures. The highway reconstruction and protective work has been carried out under recent contract by Tieslau Bros., under the direction of J. H. Skeggs, district engineer, California State Highway Commission.

Concrete Gun Lining Work in Duboce Tunnel

San Francisco Municipal Traffic Tunnel Lining Includes Large Yardage Placed With Concrete Gun Supplemented With Grouting—Forming Methods—Simultaneous Heading Operations

THE DUBOCE tunnel in San Francisco, a municipal traffic improvement, is 4,232 ft. long, and is being built by contract on the assessment district plan. It is to provide a more direct route between the downtown district and a residential section, like the Twin Peaks tunnel, not far distant, which was built by the city thirteen years ago. The cross-section of the new tunnel was selected to accommodate a double-track street railway line, and as the project was undertaken primarily to facilitate extension of the municipal railway system into the Sunset district (see *Engineering News-Record*, June 10, 1926, p. 959), no provision is made for vehicular traffic.

Excavation for the tunnel was started June 11, 1926, under a contract that allowed 450 days for completion of the job. At times considerable water was encountered, but in the main the material traversed was solid and stood well, barring some soft serpentine in which considerable swelling occurred. The tunnel had to be timbered for practically its entire length, a seven-segment arch being used with 10x12-in. timbers set close together.

The method of driving was to advance first a pilot drift at the crown of the arch followed by wall plate drifts on either side. Because of the width of the tunnel, it was most economical to use a power shovel for mucking. The work was advanced from both portals, but because of the 3 per cent grade downhill to the east and because of the greater convenience in disposing of muck from the east portal 75 per cent of the driving and all of the concrete lining was done from that end. Concreting started late in January, 1927, and was completed early in October.

Because the concrete lining had to be placed simultaneously with the advancement of the heading, it was necessary to carry on lining operations without interference with muck trains going to and from the heading. On the heading work three shifts were employed continuously, while the lining was done in a single 8-hr. shift, placing 40 ft. of arch (about 220 cu.yd.) per day. Only the moving of forms had to be done between the shifts in which lining concrete was poured.

The aggregate bunkers and concrete-mixing plant were located at the east portal. The street here climbs the hill at a fairly steep grade, so that a short timber incline enabled trucks to dump on top of the bunkers, whence the materials moved by gravity through the mixer. The latter delivered, also by gravity, to concrete cars on tracks in the approach cut.

Concrete was taken into the tunnel in two-car trains drawn by gasoline locomotives. The concreting operations were kept at least 200 ft. back of the face. Due to the downgrade to the east, gasoline motors could be used without involving any problem in ventilation. On the west end, where only 25 per cent of the yardage was taken out, motor dump-trucks with engines shut off backed down to the heading face by gravity and were drawn out by a cable to a winch at the portal.

Formwork and Reinforcement—In placing the forms for the concrete lining, the first step was to lay a 6x8-in. timber sill on the floor of the tunnel, marking the foot of the side wall. This sill was set to line and grade with a transit; this operation provided the only exact alignment required throughout the process of setting the forms. The sill was held in position by wires passed around the plumb posts and twisted up to hold it firmly against struts also extending from sill to plumb posts.

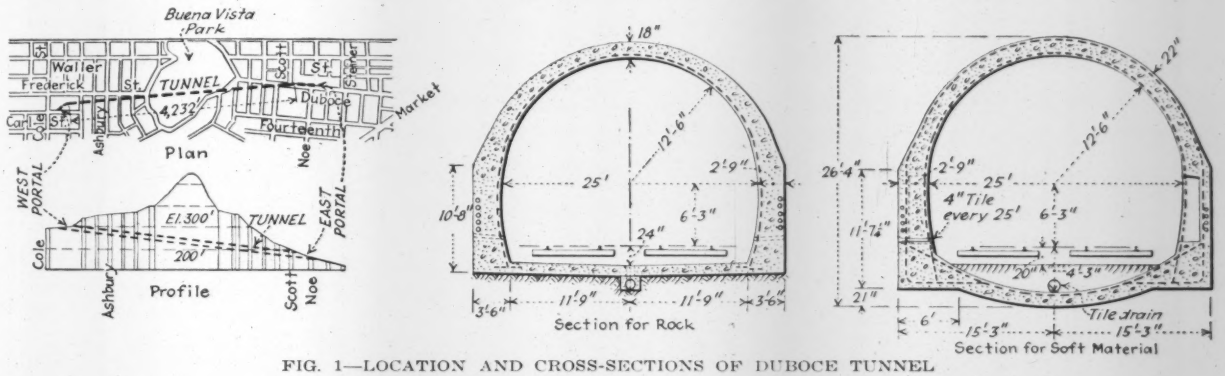


FIG. 1—LOCATION AND CROSS-SECTIONS OF DUBOCE TUNNEL

A run of these sills, accurately aligned, constituted the footing and anchorage for the first forms for concrete in the side walls. These forms consisted of $\frac{3}{16}$-in. steel plates in 4x10-ft. sizes with 3x3-in. angles on all edges and a few in the middle for stiffeners. A 2x6-in. timber key was fastened along the lower (10-ft.) edge to facilitate bonding with the invert.

On this same lower edge holes had been drilled at intervals in the angle iron so that, when the form was set vertically on the sill, spikes could be driven down through the angle iron to hold the forms in place at the bottom. At the top each plate was held in alignment by short lengths of reinforcing steel. These rods were sharpened at one end and bent over so that they could be driven into the plumb posts, while the other end was bent to fit over the angle along the top of the steel plates. Light wood spacers kept the plate away from the plumb posts prior to the pouring of concrete.

Reinforcing steel in the side walls was set 12 in. on centers in lengths of 12 ft. before the vertical steel forms just described were set. This reinforcement was arranged so that alternate bars turned outward to provide for bond with the invert, and the others turned

back into the concrete wall. Thus the ends of a series of 1x6 boards in 24-in. lengths placed beneath the vertical steel form could be separated just enough to leave spaces through which the alternate reinforcing rods could project into the space to be later occupied by the invert.

Holes were drilled in the vertical steel form plates 30 in. apart horizontally and 9 in. from the top, through which $\frac{7}{8}$-in. bolts were allowed to project horizontally to serve as anchorages for the arch forms. These bolts were 14 in. long and were provided with nuts on the inner ends to anchor them in place. They were placed

FIG. 2—BUNKERS AND CONCRETE-MIXING PLANT, EAST PORTAL
A single 1-cu.yd. mixer was used. Street slope made necessary only a short truck ramp.

in the green concrete as the pouring neared the top of the forms.

Reinforcing steel in the arch consisted of $\frac{3}{4}$-in. square corrugated bars placed 12 in. on centers, 3 in. from the face of the concrete lining. The bars were full-length, were bent outside the tunnel to the desired curve, and were placed from a jumbo 40 ft. long designed so that it spanned and gave clearance over the two tracks on which the muck and concrete cars were operated. Because it was useful both in placing steel and in working under the arch forms while the concrete was being placed, it was known as the working jumbo. It was wedged against the arch forms to give them the support of a horizontal strut while the concrete was being placed. This jumbo was usually removed immediately after the forms had been filled.

In traversing soft material a double system of arch reinforcing was used, and here, before placing the steel rods in the outer system, concrete blocks were wired to each rod to maintain the proper spacing from the timber sets. The concrete blocks on one side of the curve were fastened firmly in place; those on the other side were left loose while the rods were being placed, and then were slipped along the rods to a point where they could be wedged firmly into position against the timbers.

With the reinforcing fastened in place, the steel arch forms were brought up, one section at a time, on a second jumbo 10 ft. long. These forms were made up in 10-ft. sections weighing 10,000 lb. each, and four of these sections were bolted in place to constitute the 40-ft. length of the tunnel prepared for each day's pour. The form jumbo was provided with a jack on each of the four corners for lifting the form section to the proper height. Workmen on the floor of the tunnel then pushed out the sides of the steel forms by hand, threading through holes in the lower edges of the forms the bolts that had been bedded in the first concrete pour, and finally placing on these bolts the nuts that clamped the forms into exact position. To facilitate removal each form section was hinged on either side of the crown and thus the sides swung easily into position when the weight was supported on the four jacks of the form jumbo.

The four 10-ft. arch sections were bolted together at adjacent edges and the forward or open end of the forms was closed off with a bulkhead of 1-in. boards held in place by being slipped under an angle bar bent to the same radius as the forms and bolted to the end form rib.

Concreting Operations—The concrete gun was carried on a jumbo provided with a 25-ft. cantilever support for the 7-in. delivery pipe. The pipe projected 15 ft. beyond the end of this cantilever and thus, by removing temporary blocking at the end of the cantilever, a 40-ft. length of the delivery pipe could be thrust into the steel lining forms along the top of the arch.

The Duboce tunnel is wide enough so that the gun could be located on the tunnel center line and still allow space on either side for the passage of concrete- and muck-cars. Central location for the gun gave the advantage of two simple curves (of 15-ft. radius) in the delivery pipe, thereby materially increasing its life as compared with what would be expected with a compound curve.

The concrete gun was the same type and the other equipment was similar to that used on the Skagit and Pit 3 tunnels (see *Engineering News-Record*, Oct. 30, 1924, p. 700, and July 23, 1925, p. 128). The gun had a capacity of 3 cu.yd., was suspended just above the tunnel

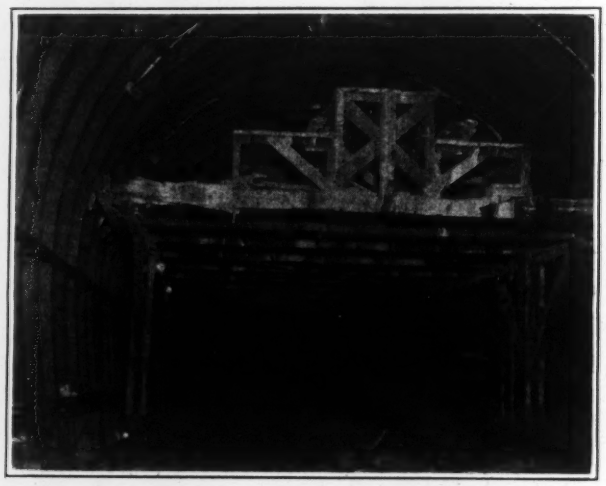


FIG. 3—WORKING JUMBO WEDGED INTO PLACE AGAINST FORMS
This car, 40 ft. long, was used first for placing arch reinforcing and then for bracing and working under forms as shown in the illustration.

floor on four $1\frac{1}{4}$-in. steel rods, and was braced against longitudinal movement by inclined 3x10-in. planks. By mounting the gun close to the tunnel floor it could receive its charge by gravity from dump cars.

These cars were of 3 cu.yd. capacity and were specially designed for this job. They had sloping ends, a flat bottom and vertical sides and were arranged to be tilted so as to dump on either side. The frame beneath the car

body was provided with two 1½-in. steel pins that could be transferred from one side to the other, giving the effect of hinging the support of the body. Under the center of the body was a 12-in. air cylinder whose piston was thrust vertically upward when it was desired to dump the car. As this piston moved upward a roller on its top moved along a channel iron attached to the under side of the car body, raising one side and revolving the body about a horizontal line through the hinge pins. This arrangement gave a short cylinder stroke and very speedily tilted the body into dumping position. By designing the cylinder so that it did not have power enough to raise the weight of the car body filled with concrete, it was made more or less "foolproof." That is, when the car was in position for dumping and the gate on one side was opened to allow concrete to flow into the gun, the car was quickly relieved of enough of the load so that the cylinder could tilt it to facilitate complete delivery of the contents. The air hose for operating the dumping cylinder hung from a convenient point on the concrete gun jumbo and was fitted with a quick detachable coupling. The valve was controlled by the engineer on the concrete train, who operated it on signal from the concrete-gun operator.

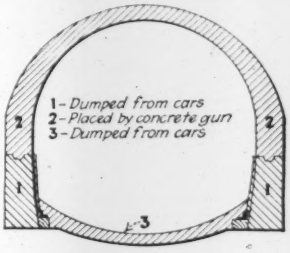


FIG. 4—SKETCH SHOWING SEQUENCE IN LINING OPERATIONS

There were two men on the concrete gun and two on each concrete train; these crews did all work connected with delivering concrete from the mixer into the tunnel forms. The gun ordinarily delivered a 3-yd. batch in about 40 seconds. While exact measurements of the amount of compressed air required to operate the gun were not made, a compressor capacity of 1,200 cu.ft. per minute sufficed for a delivery from the gun of about 30 cu.yd. per hour. This was the average rate of placement on the Duboce job, although, using 110-lb. air pressure, as much as 40 cu.yd. was placed in one hour. The air line into the tunnel was 4 in. in diameter and the air connections on the gun jumbo were served by a 3-in. rubber hose. The use of a flexible supply line made the air supply to the gun independent of the frequent short moves involved in working back and forth along the day's set-up of forms.

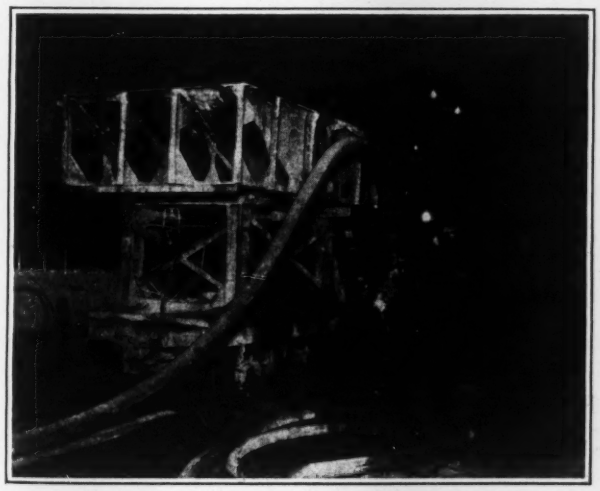


FIG. 5—THE 3-CU.YD. CONCRETE GUN RECEIVING A CHARGE

Gun was suspended from the gun jumbo. Operator's station at valves beyond end of 3-in. rubber air hose. Delivery pipe in right background.

FIG. 6—LINING FORMS AND FINISHED ARCH SECTION

The end of the pipe through which concrete was delivered into the forms was equipped with a baffle box that cushioned the discharge of concrete on itself and prevented destructive violence in the delivery. This box was supplemented by "butterfly wings" on either side which were in reality curved steel troughs about 8 ft. long in which the concrete flowed from the baffle box over the flatter portions of the arch form. The advantage of this arrangement was that concrete leavings did not remain on the upper portion of the arch forms during the interval between the beginning and completion of the pour in a 40-ft. length of the tunnel. Such concrete leavings would be likely to take initial set on this part of the forms before the arch was poured, thus making pockets in the finished job that would have to be patched.

The gun jumbo was almost continuously moving up and down the tunnel for the full length of the 40-ft. form section while in the act of delivering, the plan being to place the lining in layers 6 to 12 in. deep. To do this the gun jumbo would often make as many as 20 or 25 trips to and fro along the form in filling a 40-ft. section. No delay was involved in this moving because it was done by the helper at the concrete gun operating a small air-driven winch on signals from the foreman. Around the head of this winch were passed two or three turns of cable whose ends were made fast at anchor points up and down the tunnel so that the jumbo could be moved in either direction. The baffle box and its wings were provided with runners that rode easily over the reinforcing steel, so there was no danger of displacing the reinforcing as the delivery pipe was moved. With this arrangement of the concrete delivery system, concrete could be placed uniformly in the forms without segregation.

The arrangement of the four 1½-in. air pipes into the concrete gun is designed to afford adequate aëration of the batch as it passes out into the delivery line, and the flow through the delivery pipe is a uniform and continuous process. There were no plugs in the delivery line on this entire job.

It was observed that if the delivery end of the pipe was left open and allowed to discharge against a steel baffle very rapid wear occurred, whereas with a baffle box on the ends of the pipe the concrete formed its own cushion and not only was the wear minimized but the homogeneity of the batch was maintained during the process of delivery. Evidence that the concrete served as its own cushion in this baffle box appeared in the continuous service, without renewals, of the baffle box put in when the job started. Either side of the baffle box was closed up when it was desired to deliver to only one side of the forms.

Each 10-ft. section of the forms had an inspection portal or window about half-way up the wall, and until concrete reached the spring line of the arch a workman was kept in each wall to walk up and down in the concrete and do such spading as was necessary to insure getting the concrete properly around the reinforcement. A very smooth finish on the face of the lining was secured by tapping the inner face of the steel forms with light pneumatic hammers after the form was filled.

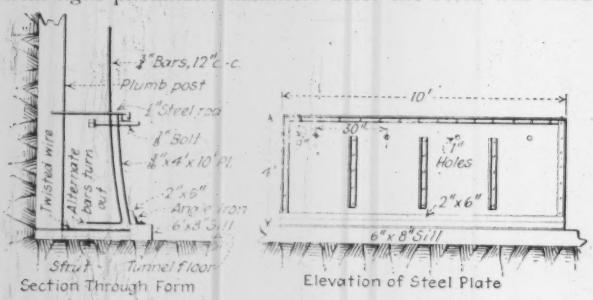


FIG. 7—DETAILS OF FORMS AT BASE OF SIDE WALLS

Two men were kept on this work continuously during the latter part of each pour.

When both sides of the arch forms were filled up to the wings the latter were removed, and when only the crown section remained to be concreted the baffle box itself was removed and the end of the delivery pipe was thrust into the forms for its full length. The crown was then placed by backing out the delivery pipe as the concrete filled the forms. By careful operation on the part of the foreman in signaling for moves of the delivery pipe while placing the crown, it was found possible to keep the extreme end of the delivery pipe just embedded in the concrete and thus to secure the same baffle effect that was obtained with the use of the baffle box.

The concrete lining called for by the specifications was 18 in. thick in the clear inside of timbers in the rock section, and 22 in. thick in the soft ground. The average yardage placed in the lining throughout the length of the tunnel is estimated to be 7 cu.yd. per foot.

Concrete Mix and Grouting—The concrete put through the gun consisted, roughly, of a $1\frac{1}{4}:2\frac{1}{4}:4\frac{1}{2}$ mix. The coarse aggregate was $\frac{1}{4}$ to $1\frac{1}{2}$-in. gravel artificially graded and the proportions worked out to give 5 sacks of cement to each cubic yard of concrete in place. The dry weight was 110 lb. per cu.ft., with 35 per cent voids. The total amount of water was 55 lb. ($6\frac{1}{2}$ gal.) per sack of cement. An average of 34 strength tests showed 2,320 lb. per sq.in. in 28 days.

Usually in every second steel form section, i.e., 20 ft. apart, a 2-in. grout pipe was left projecting into the crown of the arch, for injecting grout under pressure after the lining had been placed. The grouting was done with a grout gun having a capacity of about $\frac{1}{3}$ cu.yd., consisting of a vertical cylinder with an inverted cone-shaped base. Grout was delivered at the upper end of the cylinder through a circular door and forced out through a 2-in. delivery line at the base under 110-lb. air pressure. Delivery into each grout hole was continued until grout appeared at the next hole ahead. The average amount of grout taken up in this tunnel was about 15 cu.ft. per lineal foot. Where there was large overbreak or other spaces filled in by packing behind the arch timbers additional grout pipes were used.

Air Supply—The air compressor installation serving all phases of the driving and lining operations on the Duboce bore consisted of a 2,200-cu.ft. compressor at the east portal supplemented by a 440-cu.ft. standby or reserve unit, and at the west portal by a 450-ft. compressor unit. If the concrete gun were to be used alone it was stated that the compressor installation that would be selected for conditions similar to those used on the Duboce job would be about 1,200 cu.ft.

In looking over the equipment used on this job it was notable that unusual confidence was shown in the dependability of the concrete gun and the equipment used in connection with it. Only one gun was provided, there were no extra sets of arch form units and only the number of cars and locomotives needed to actually maintain a continuous concrete supply were on the job. Organization of the work, however, was such that lining operations went on smoothly and without interruption from the start. After the excavation was completed the lining progress was increased to 40 ft. per day and continued at this rate without loss of a single pour until the entire arch had been placed. The average concrete yardage placed with the gun on an 8-hr. pour was about 220 cu.yd. By use of additional forms and a second concrete shift to complete the pour, engineers in charge of the work were sure that even in this large tunnel a daily progress of 70 to 80 ft. of concrete lining per day could have been made.

The tunnel was designed under the direction of M. M. O'Shaughnessy, city engineer of San Francisco; M. J. Bartell was resident engineer for the city. R. C. Hackley, who personally supervised the construction of the tunnel as an associate of the contractors, developed the collapsible steel forms, the special concrete cars, the Hackley gun and the system of discharge by which concrete is deposited in horizontal layers. The gun and the system of delivery are patented. The contract is held by the Youdall Construction Co., R. G. Clifford, chief engineer.

Florida Everglades Reclamation

For the excavation of a system of long canals for drainage, which has been carried on for the past twenty years by the Everglades Drainage District, comprising about 4,000,000 acres in southern Florida, there had been expended up to Jan. 1, 1927, a total of $15,000,000. About $5,000,000 of this was used for construction of the St. Lucie canal for the control of Lake Okeechobee. In May, 1927, an engineering board recommended a revised canal system and a levee for Lake Okeechobee, estimated to cost an additional $2,600,000. In April, 1927, the Florida Legislature passed an act authorizing a bond issue of $20,000,000, but the act was declared unconstitutional and the district has discontinued construction. Some progress is being made, however, by smaller drainage districts, organized within the Everglades District, which are in some cases digging their own outlets as well as their main drainage canals.

Letters to the Editor

A Forum for Discussion of Views of Engineers and Contractors

Rivets and Riveting

Sir—During the past year the structural rivet has been subjected to a good deal of criticism and investigation; criticism by advocates of welding and investigation by its many friends. Its use in tension has increased, although as yet hardly any specification has sanctioned this by assigning definite working stresses for this condition. Prof. C. R. Young, of Toronto University, in his recent paper on "Tensile Working Stress for Rivets" [abstracted on p. 188 of this issue of *Engineering News-Record*], has proposed such a specification, based on results of tests by himself and others. To structural engineers his paper is of great interest, both because of its contents and also because of the many queries it rouses in our minds. It seems to me that there are many features of our rivets for which, if they have been investigated, the data are hard to locate in engineering literature.

Let us start with our rivet as it is withdrawn from the forge and thrown to the riveting gang. Professor Young took measurements of its temperature while in the heating oven and at start of driving. He found furnace temperatures averaging 2,207 deg. F. and rivet temperatures at start of driving averaging 1,892 deg. F. The rivet is then placed in its appointed hole and a pneumatic hammer starts pounding on it. If Professor Young measured its temperature at the instant the hammer ceased pounding, he does not mention it. I think it may prove of interest, because our rivet is now gripping the material tightly while continuing to cool. We assume that the rivet has been expanded so that it completely fills the hole. Does it? The material around the hole has been heated and thereby expanded. Where or in which direction can this expansion take place? It seems to me that it must tend to decrease the size of the hole.

Our rivet is cooling—giving off heat to the air and the material gripped. The mass of the latter being much greater than the rivet, the temperature of the gripped material will not rise nearly as rapidly as that of the rivet will fall. The temperature of the rivet as the hammer stops cannot be much less than 900 deg. F. If we realize that a change in temperature difference between rivet and gripped material of about 200 deg. F. means an initial stress in the rivet shank of about 38,800 lb. per sq.in., which is close to the yield point of the material, we can visualize our rivet rapidly being stressed beyond the elastic limit and elongating enough to bring the stress below this point. Then it continues cooling and getting overstressed until finally a stable condition is reached with equalized temperatures at normal range and an initial stress in the rivet of close to the elastic limit. Professor Young found that the ultimate strength of the rivets after driving was greater than that of the material from which they were made. If my story is right, this should be expected, since the working the material has received in cooling would produce this very result.

How about the diameter of the hole? Evidently it is now greater than when the hammer stopped pounding. And the diameter of the rivet shank? For one thing it has been cooled off a considerable amount and has therefore contracted; but that is not all. It has been repeatedly stretched beyond its yield point, and that has further contracted it. There are, then, three distinct reasons why the rivet shank cannot possibly ever completely fill the hole.

How will this affect the distribution of stresses at a column splice or any joint taking compression? It seems that, in order to bring the rivets to take shear, a certain amount of displacement must take place and that, in order for this displacement to take place, the friction between the materials gripped must be overcome. How great is this friction? And do we want this displacement to take place? If not, then evidently we shall want by all means to increase this friction. Is it then advisable to paint inaccessible surfaces before assembling? Are any tests available as to the amount of this friction? Professor Ketchum's "Handbook for Structural Engineers" still carries the statement, "Rivets should never be used in tension." Before we realize it, we shall be advocating that rivets should "preferably" be used in pure tension, because, unless they are loose in the holes, they are already carrying this stress. And the stress cannot be increased until the initial stress is balanced, as Professor Young has demonstrated in his paper and as Mr. Godfrey demonstrated years ago in the columns of your paper.

We may find that pure tension is difficult to produce, but the heavier we make our connecting members the closer we shall approach this condition. Indeed, to develop tensile rivet stresses of usable intensities, heavy connection members are necessary. An angle leg $\frac{3}{8}$ in. thick will be found to have actually weakened materially our maximum obtainable rivet resistance.

Detroit, Mich., Jan. 14, 1928. S. J. Warberg, Registered Structural Engineer.

Thin Dams Have Many Advantages

Sir—Your editorial in the issue of December 22, p. 987, entitled "Dams—Thin and Massive" is interesting and conservative and brings out some important points to be considered in the design and construction of thin dams.

The art of designing, specifying and constructing reinforced-concrete work has now progressed to such a state that results in the hands of qualified persons can be predicted with certainty. Concrete is now produced in modern mixing and handling plants which approaches steel and other construction materials in its uniform strength and other physical characteristics. By selecting proper materials and by proper handling, durable concrete can be produced with practical certainty.

It is not always economical to use a thin dam of reinforced concrete. There are foundation conditions which make the use of thin reinforced dams unadvisable, although their first cost may be lowest. On the other hand, there are many situations to which a reinforced-concrete dam of thin sections is well suited and where a substantial saving in the first cost of the dam can be made. Unfortunately, the more expensive gravity type of dam is frequently selected because of the uncertainty in the minds of engineers and owners as to the safety of a reinforced-concrete dam. It seems to the writer that the engineering profession might well give serious consideration now to the advantages of reinforced-concrete dams of thin section and use them when the natural conditions favor this type of construction.

Minneapolis, Minn., Dec. 28, 1927. Walter H. Wheeler, Consulting Engineer.

Reclamation and Flood Control Costs

Sir—In your Dec. 22 issue you have an editorial entitled "Public Money and Private Cupidity." Quoting from this editorial: "The perennial example is furnished by the ever-repeated requests of the federal reclamation landholders for postponement of their contractual repayment of costs to the government." And again, "The reclamation difficulties grow out of the evil of undertaking land development for private benefit through government funds loaned without interest, to be repaid at some variable time in the future. But even beyond this is the underlying evil of deficient moral sense toward public obligations. Only by impartial enforcement of these obligations through the government officials to whom they are intrusted can this evil be checked."

In your issue of Dec. 15, in the report of Major-General Edgar Jadwin on the Mississippi Valley, you quote from his report, "The suggestion is made that a distribution by which the cost of flood control in general is borne 80 per cent by the federal government and 20 per cent by the valley states, and the entire cost of channel stabilization is borne by the United States, would accord with the fiscal policy of the President and the precedents established by Congress." In

your Dec. 22 summary of the Mississippi River Commission report the cost allocation is not so definite as that of Gen. Jadwin, but infers somewhat the same plan.

The levee system of the Mississippi is for the purpose of making available land for farming and protecting the towns created by these farms. A Western irrigation project is no different. It makes available land for farming and towns grow in it due to this farming. It is the policy of Congress that the irrigation farmer pay the *entire* cost of the works that make possible his living on the irrigated farm, as well as the cost of their maintenance and operation. But it is proposed that the farmer in the flood-control district pay only 20 per cent of the cost of the works that make possible his living on his farm protected from floods, and the United States (including the irrigation farmer) pay the remaining 80 per cent of the cost.

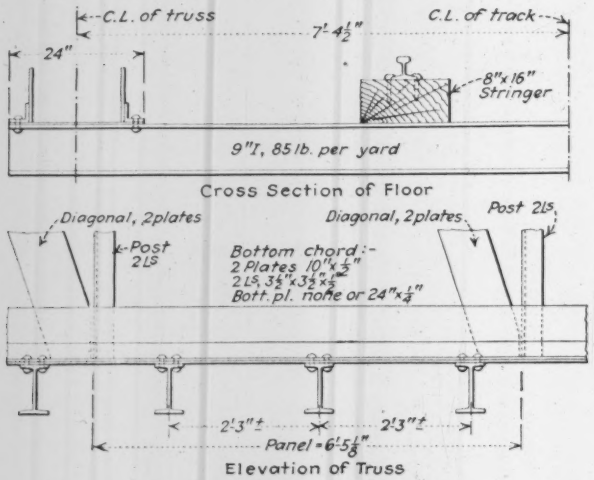
From the Jadwin report it appears that in the Mississippi Valley 20,500 square miles can be protected at a cost of $296,400,000, or a cost of $23 per acre. Deducting the $110,000,000 for channel stabilization the cost is $14 per acre. The cost per acre of most any irrigation project is in excess of this.

Of course it is evident if a farmer in a flood-control district contracts to repay but a small percentage of the cost of the works making his farm possible, he stands but a small chance of ever being criticised for not living up to his contracts. But the question at once arises, Why not apply the same rules of repayment to the reclamation by flood control as are made to apply to reclamation by irrigation? And why should not the government policy for the Mississippi Valley farmer be the same as for the Western farmer?

Omak, Wash. HORACE M. HOLMES.
Jan. 2, 1928.

An Example of Rivets in Tension in an Old Railroad Bridge

Sir—The report of the discussion on tension in rivets at the annual meeting of the American Institute of Steel Construction, *Engineering News-Record*, Nov. 3, 1927, p. 716, was of particular interest to the writer in view of an unusual example of such construction which recently came to his attention. This construction was found in an old 122-ft. span railway bridge described in the "Report of the Board of Railroad Commissioners of the State of New York on Strains on Railroad Bridges of the State," June 30, 1891, p. 441. In this bridge the floor construction was such that the floor



DETAILS OF BRIDGE SHOWING RIVETS IN TENSION

and train load were supported wholly by rivets in tension as shown by the accompanying detail. The bridge was built in 1863 and stood until 1901, when it was replaced by a heavy modern bridge.

The floor construction was of transverse, 9-in. 84-lb. I-beams placed about 27 in. between centers and supporting the wooden stringers and rails. The floor beams were connected to each chord by four 1-in. rivets, passing through the upper flange of the I-beam and the lower chord angles.

The loads carried by this bridge are a matter of speculation, but it is very probable that locomotives with 25,000-lb. axle load passed over it. For a consolidation locomotive with axle spacing about 5 ft., the distribution of the load on the floor would be about 50 per cent of the axle load to each floor beam. Thus, with a dead load of 900 lb., the maximum direct load on each floor beam was about 13,400 lb., to which could probably be added impact on the basis of a speed in excess of 15 miles per hour, say 100 per cent of the live load, or 12,500 lb. Thus, with a maximum total load of 25,900 lb., the maximum stress in each of the eight rivets would be as follows: For dead and live loads, 1,675 lb.; for dead, live and impact loads, 3,238 lb. On the basis of a shearing value of 10,000 lb. per sq.in. for dead, live and impact stresses, reduced 25 per cent in case of hand-driven and floor connection rivets, the allowable shear in these rivets is 5,890 lb. and the actual tension of 3,238 lb. is 55 per cent of their value in shear. It is interesting and important to note that the rivets withstood such a stress for a long period of time without showing signs of distress.

The writer wishes to call attention to a few important American specifications that place a value on rivets in tension. These are the standard specifications for highway bridges adopted by the United States Department of Agriculture, allowing a tension value equal to 50 per cent of the shear value; those issued by the American Association of State Highway Officials, also allowing a tension value of 50 per cent of the shear value; and the specifications issued by the Port of New York Authority for use in construction of the Hudson River bridge, allowing a tension value for rivets equal to 40 per cent of their value in shear.

New York City, Dec. 5, 1927. HAROLD D. HUSSEY, American Bridge Company.

Mechanical Analysis of Structures

Sir—In applying the method of Prof. G. E. Beggs for solving statically indeterminate structures mechanically by making a small model and obtaining stresses and reactions by measuring deflections or strains, care should be taken to have the moments of inertia of every section of the model proportional to those of the proposed structure. Otherwise the deflections of the model will not be proportional to those of the structure.

For example, in making a model of a bent having knee-braces between columns and roof beams (a familiar New York City subway type), consideration should be given not only to the moments of inertia of columns, beams and braces individually but also to the moment of inertia of any section through the entire structure, as one cutting a roof beam and brace. Supplying proper areas of model members as well as moments of inertia will take the moment of inertia of the section into account.

In making a model of a truss the members of which take only axial stresses, the relation between the length and area of each member of the model should be proportional to that of the proposed structure without regard, ordinarily, to the moment of inertia of each individual member. When the members also take bending due to secondary stresses, eccentricity, stiff joints or continuity of chord members, the moments of inertia in the plane of bending as well as areas should be considered.

When the model members are made of cardboard or celluloid, area can be best varied by the thickness of material and moment of inertia by depth. Circular sections, as wires, are not readily adapted for varying both area and moment of inertia, as the area varies as the square of the diameter and the moment of inertia as the fourth power, but wires are more convenient than celluloid for bents without braces and for trusses taking no secondary stresses.

New York City, Jan. 12. MORRIS BERMAN.

News of the Week

Current Events in the Civil Engineering and Contracting Fields

Exhibits Are Feature At the Ninth A.G.C. Annual Convention

Close Association Developed Through Isolation of Meeting Place—Membership 2,300

(*Engineering News-Record Staff Report*)

WITH an attendance of about 300 actual members and an equal number of guests and exhibitors, the ninth annual convention of the Associated General Contractors last week at West Baden, Ind., proved one of the most successful in business transacted which the association has ever held. An innovation at this convention was the presence of threescore or more exhibits of construction materials and equipment and builders' supplies. There was an excellent entertainment program and the isolated location of the meeting developed an unusual amount of close association and informal conference of members outside of the regular sessions.

As has been the custom, each session following the formal opening combined special papers and standing committee reports, and on one of the three days separate sessions were held by the building division and the highways and public works division. Condensed summaries of the standing committee reports are published in this issue, and the presentation and discussion of these reports constituted the real business of the convention. Chief discussion was aroused by the part of the report on legislation that discussed lien laws and by the reports on accident prevention, insurance and quantity surveys. Generally, the information brought out in discussion was supplementary rather than critical and carried the development of the several questions very little further than did the reports.

Outstanding Papers

Outstanding among the papers before the general sessions was that on "Methods of Accounting for Contractors' Equipment," by W. J. Hibbs, treasurer of the U.G.I. Contracting Company, and that on "Cash Investment in Construction Operations," by W. F. Creighton, of the Foster & Creighton Company, general contractors. Much of the paper by Mr. Creighton was published in *Engineering News-Record*, Jan. 19, 1928, p. 119, and an abstract of the paper by Mr. Hibbs will appear in a future issue. The discussion of all papers was limited by their special character and specific detail, which required more application than their presentation in summary permitted.

The most important action of the convention besides the election of president as noted elsewhere, was the appointment of S. M. Williams as secretary of the division of highways and public works. The budget voted for association expenses in 1928 carried items totaling $150,000. A total membership of 2,300 was reported, and it was announced that the association has 105 chapters and branches. Its finances are in good condition.

Paterson and Passaic Advised to Condemn Water-Works

Condemnation proceedings to determine the price to be paid by Paterson, Passaic and Clifton for the water-works system of the Passaic Consolidated Water Company, with headquarters at Paterson, N. J., have been recommended by a commission appointed to act in behalf of the cities in an attempt to fix the price of the property by negotiation. The commission, appointed under a state law, placed a value of $8,276,127 on the property; the company claimed $18,000,000. In 1922 the property was offered to the three communities and Montclair for $10,500,000, against $8,000,000 proposed by the municipalities. Since then Montclair has bought the distribution system in that town for $1,700,000 and the company has added to its investment in the other cities.

To Enlarge Sewage-Works at Indianapolis

An extensive sewer system to serve a north-side district which now discharges sewage into White River, and also an enlargement of the sewage-works to handle this additional volume of sewage, have been determined upon by the board of sanitary commissioners at Indianapolis, Ind., with the approval of the mayor. The cost is estimated at about $262,000 for the treatment works and $300,000 for sewers. A bond issue for this purpose must be submitted to the state tax board for approval. Detailed plans are now being prepared under the direction of Charles H. Hurd, consulting engineer.

C. V. Receivers Seek Flood Aid

Receivers of the Central Vermont Railway, in an application to the Interstate Commerce Commission, made public on Jan. 18, ask authority for an issue of $5,000,000 of 4½ per cent receivers' certificates, to be sold to Dillon, Read & Company, New York City, at 99.53 and interest, and the proceeds to be used in repairing damage to the company's lines, resulting from recent floods in New England.

Recent London Flood Caused by Tidal Bore, Heavy Rain and Snow

Water Piled Up in the Thames River By Long-Continued Winds From Two Directions

A TIDAL bore in the Thames Estuary was the chief cause of the flood that broke over the Thames Embankment, London, Jan. 6-7, according to both *The Engineer* and *Engineering* of Jan. 13. Minor contributing causes were the usual high tide at the full of the moon and a high flow down the Thames, due to rain and melting snow.

The tidal bore, says *Engineering* of Jan. 13, was "a phenomenon hitherto unrecorded in the history of the estuary." Both journals mention heavy winds from the southwest as the cause of the bore. In addition, states *The Engineer*, a heavy wind had been blowing for some days from the northwest, "forcing water from the Atlantic Ocean round the north of Scotland and down the east coast." That is, water was piled up at the mouth of the Thames from both directions, elevating "the water in the Thames Estuary," *The Engineer* states, "to a height greater than, as far as we are aware, had ever previously been experienced." This height is given by *Engineering* as 6 ft. 1 in. above the predicted height of 21 ft. 1 in. at Old Swan Pier. The normal tide at the time was that of the full moon, says *The Engineer*, which ordinarily would have meant a "rise of some 1 ft. 6 in. above Trinity high-water mark, which certainly would not, of itself, cause the river to overflow."

The flow of the Thames at Teddington Weir, a few miles above London, for Friday, Jan. 6, was 9,000,000,000 Imp.gal. against 11,000,000,000 recorded one day in 1915. By itself alone the 9,000,000,000-gal. flow, says *The Engineer*, would not "raise the level of the river in the neighborhood of, say, Westminster" by more than "a few inches; certainly by not more than 1 ft. at high water."

Neither of the journals from which quotations have been made gives much more than casual information as to the extent and effect of flood. In fact, *Engineering* says nothing. *The Engineer* says:

> In the early morning of Saturday last [Jan. 7] the River Thames rose to a level never previously reached, with the result that it overflowed and even burst the Embankment at various points, and there was a most regrettable loss of life, principally among persons sleeping in basement rooms in houses near the river. . . . Apart

(*Continued on p. 209, col. 1*)

Steel Tank of 40,000 Gal. Falls On Building During High Wind in New York

During a 24-hour period of high wind velocity in New York City Jan. 25, a 40,000-gal. elevated steel tank with hemispherical bottom located on an 11-story building along the Hudson River waterfront collapsed, breaking through the roof and three floors. It came to rest on the eighth floor, flooding the building with practically a full tank of water in addition to the water contained in two 15,000-gal. pressure tanks, also on the roof, the connections of which were broken.

The tank, which was 14 years old, was built to plans approved by the city's authorities. The tank and tower in themselves were not unusual, the tank being 17 ft. in diameter with a shell 18 ft. high surmounted by a conical roof, and the tower being in two 12-ft. panels with vertical posts, of two 6x4x½-in. angles, struts each of two angles 3½x3x5/16 and diagonal wind bracing of 1-in. upset adjustable rods.

In connecting the tower to the building, a rather comprehensive arrangement of trusses was provided in order to distribute the weight of the installation over twelve building columns. These were hollow cast-iron columns about 9 in. in diameter inclosed in about 1 in. of fireproofing. The trusses, about 8 ft. deep, were supported on short built-up H-section columns about 30 in. high. The shoe plates of the trusses were riveted to plates on top of short column sections while through these plates on the bottom of the column sections four bolts made the connection to the building column. The plan dimensions of the truss layout were 42x38 ft. and the total tank and tower superstructure height from the building roof to the eaves of the conical tank roof was 38 ft.

During the day a whirling action was noticed in the wind atop several tall buildings, and it is believed that one or two of the column connections were twisted loose by such a wind, causing the collapse of the entire structure. The Weather Bureau's instruments, which are in about the same exposed position as was the tank, recorded the highest velocity for a five-minute period to be 72 m.p.h. Short gusts of wind may have reached a much higher velocity. The 72-m.p.h. figure was recorded with the Weather Bureau's new three-cup anemometer and represents true wind velocity.

To Irrigate Central Park

To irrigate Central Park, New York City, the Board of Estimate and Apportionment voted on Jan. 26 an appropriation of $263,360. The appropriation was made in accordance with recommendations of experts appointed last spring, and the work will mark the beginning of an extensive irrigation system.

NEW A. G. C. PRESIDENT

W. A. Bechtel, of San Francisco, Is New A. G. C. Head

Has Long Been in Contracting Work in West—Helped to Organize California Chapter

WARREN A. BECHTEL, elected president of the Associated General Contractors at its meeting in West Baden, Ind., Jan. 23-27, is the head of the W. A. Bechtel Company, of San Francisco, doing a general contracting business. He was one of the organizers, in 1919, of the Contractors Association of Northern California and was its second president. When the Associated General Contractors was organized, he became a member and has been continuously active in its affairs. Since 1926 he has been a director for districts 14 and 15.

Born on a farm near Freeport, Ill., on Sept. 12, 1872, he attended school there and at Peabody, Kan., whither his father had moved. On graduating from high school he was given the choice of attending the University of Kansas or working on a farm owned by his father. He chose the latter, but four years of farm life sufficed and he went to work for the Bethune-Craney Construction Company of St. Louis, then building lines westward from Chickasha, Okla., for the Chicago, Rock Island & Pacific Railway.

After this job was completed, Mr. Bechtel worked as foreman for several contractors engaged in railroad construction, gradually working westward. Finally he had saved money enough to go into business for himself and became sub-contractor in the construction of the Western Pacific Railroad on contracts at Marysville, Pleasanton and Altamont, Calif. Later he was identified with the work on the protection levee at Oroville and with the Western Pacific terminal work at Oroville.

From there he went to Oregon, taking a sub-contract for the Utah Construction Company on the Natron cutoff for the Southern Pacific Railway. Following this he was engaged in construction work on the Northwestern Pacific in the Eel River canyon and double-track work on the Denver & Rio Grande at Soldier Summit, Utah. In 1920 he completed the first highway job in California for the U. S. Bureau of Public Roads, on the Klamath River, and a second job in San Gabriel canyon.

When his two older sons returned from the World War and a third son had reached his majority, he took them into the business, which was incorporated under the name of the W. A. Bechtel Company. Of late years the company has been doing a large amount of public utility, irrigation and railroad construction work as well as railway maintenance work for a number of Western railroads. Recently it completed the second largest rock-fill dam in the world and now has under construction a 4-mile water tunnel with diversion dam; 40 miles of double tracking for the Santa Fe Railroad in New Mexico and Arizona, and a branch line for the Western Pacific Railroad with a water front terminal in connection therewith.

Low Bid, $8,229,177 High, $14,972,985, on Harlem River Tunnel

The George H. Flinn Corporation was the lowest of seventeen bidders on the first section of the new Bronx subway in the city of New York, it was announced at the offices of the New York Board of Transportation on Jan. 28. The Flinn company's bid was $8,229,177 and the bids ranged from that figure to the highest bid, $14,972,985.

The Bronx subway will extend from St. Nicholas Ave., at the upper end of the new West Side line, across under 155th St. and 161st St. to the Grand Concourse and north under that highway.

The first section includes the part from St. Nicholas Ave. to River Ave. and 161st St. The contract includes the tunnel under the Harlem River. The contractor who gets the award will be allowed 39 months to complete it.

The bids received for the first section were as follows:

George H. Flinn Corporation	$8,229,177.00
Rodgers & Hagerty	8,422,974.85
Corson Construction Corporation	8,439,760.00
Patrick McGovern, Inc.	8,447,854.50
Triest Construction Corporation	8,577,499.00
Arthur McMullen Company	8,746,564.00
Slattery-Daino Company, Inc.	9,104,630.00
D. C. Serber, Inc.	9,599,400.00
Arthur A. Johnson Corporation	9,693,639.00
Cornell Construction Corporation	10,212,905.00
Del Balso Construction Corporation	10,412,130.00
J. F. Cogan Company	10,485,282.00
Sub-Surface Corporation	11,108,669.50
La Rocca Construction Corporation	12,505,364.00
Maurice Blumenthal	12,991,089.00
Frederick A. Cranford-Charles H. Locher, Inc.	13,254,740.00
Riverdale Waterworks Corporation	14,972,985.00

Denver Board Must Decide Soon on Moffat Tunnel Use

Whether the city of Denver will utilize the pioneer bore of the Moffat tunnel to bring an additional supply of water from the west side of the mountains must be decided by the Water Board before March 15, according to the decision of the Moffat Tunnel Commission. Lease of the tunnel for this purpose is recommended in the recent report of George W. Fuller and has been approved by the commission, but such rental must be made promptly so that any necessary lining can be done immediately, before the tunnel commission disbands.

Mr. Fuller's report, issued in pamphlet form under date of Jan. 14, outlines a "Comprehensive Plan for the Future Water Supply of Denver and Its Environs." Mr. Fuller advises the city to rent the pilot tunnel at $1 a year plus interest charges and bond retirement, the pilot tunnel to be used for delivering water from the western slope for municipal and irrigation purposes. Mr. Fuller also recommends that the city perfect its rights to water from the western slope; protect and make available as soon as practicable all the city's water rights in the South Platte River and its tributaries (the present source of supply); obtain a "plan for a comprehensive unified system of water supply for Denver to adopt, so as to serve a population up to about 1,000,000 people," thus further establishing its claims to water; reduce losses of water in operation as far as possible, and repair the Platte Canyon reservoir.

Mr. Fuller suggests that in the lease of the pilot tunnel at $1 a year and interest charge on additional outlay there be included a stipulated sum for putting the pilot tunnel in use for water service (estimated by Mr. Fuller at $1,250,000) together with specific bond retirement requirements beginning in 1943. Mr. Fuller also recommends that the city "reimburse the tunnel commission for the actual cost in the later enlarging and lining of the eastern half" of the tunnel in accordance with agreed-upon terms. Mr. Fuller estimates the cost of this work at about $700,000.

London Flood Caused by Tidal Bore

(*Continued from p. 207, col. 3*)

from the loss of life, there was very serious damage to property. . . . The water gained access to the roadways in the first instance through some of the many openings which exist [in the Thames Embankment] and, in one or two short lengths, by the destruction of old walls. In several places it ultimately surmounted the parapets.

Besides raising the Thames Embankment, the only other safeguard against excessive floods mentioned by either of the London magazines is a barrage across the Thames at Gravesend, below London, which, it appears, was proposed, discussed at considerable length and dismissed as impracticable in 1906.

Washington News

By Paul Wooton
Washington Correspondent
Engineering News-Record

Flood Control—A detailed explanation by Major-Gen. Edgar Jadwin of the Army engineer plan occupied most of the time of the flood-control committee of the House of Representatives during the past week.

John F. Stevens, appearing before the House committee in his capacity as chairman of the advisory flood-control committee of the American Society of Civil Engineers, emphasized that the hasty selection of a plan "might prove to be a mistake which later would have to be rectified at a cost which would stagger not only the nation in point of cost, but it would also shatter its confidence in its engineering world."

Continuing, Mr. Stevens declared that "a sufficient length of time should be taken to consider every factor, however apparently insignificant it may appear, that may enter into the problem, and that a study be made of correrlating and allocating these factors in the order of their importance, and only after this is done can what is called a comprehensive plan be evolved which will meet the situation. Anything less than a 100 per cent plan of protection might result in a supreme disaster, and anything more would be an added assurance of safety."

Points Made by Gen. Jadwin

Some of the points made by General Jadwin in his testimony follow:

"The fuse plug section is subject to breaks only when the water reaches the height at which it would break the levee under present conditions. The protection afforded to the floodway itself, the area of which is a very small percentage of the area of the states concerned and of the alluvial valley, is as good protection as it now has, perhaps better protection. Much of this land is of such character that it is not hurt appreciably by the water flowing over it.

"The flood-control plan which has been followed heretofore has been based on the theory of building the levees to a stage 3 ft. higher than the highest previous flood. Levees 3 ft. higher than the last previous flood would have been inadequate to take care of the 1927 flood. This flood has shown that the river needs more room. As flood stages continue to rise, we shall, if we rely on this plan, have to go on indefinitely raising our levees. The higher we raise them the more serious will be the results if a crevasse occurs.

"The only safe thing to do is to break away from the plan of arbitrarily raising these levees 3 ft. above the highest flood. Let us rather strengthen them, let the main river channel carry what water it can thus carry safely, and let the surplus escape in nature's way. The time has come to bury the 'levees only' policy lock, stock and barrel.

"The Mississippi River system is one of the chief assets of our country. It drains all or parts of 31 states and furnishes many of our cities with their water supply; it develops a large amount of power and is useful in various other ways, such as irrigation; it is one of the largest rivers in the world and certainly serves the largest population. In flood the water flowing in the lower valley is about ten times as great as that in the St. Lawrence River. The power of the river between Cairo and the Gulf of Mexico is about 60,000,000 hp. Practically all of this is consumed in chewing away the banks of the river, stirring up its bottom, and getting itself to the Gulf of Mexico."

Utilities Investigation—After having taken voluminous testimony the Senate committee on interstate commerce appointed a sub-committee consisting of Senators Sackett, Pine and Wagner to revise the Walsh resolution so as to confine the proposed investigation of utilities to matters coming clearly within federal jurisdiction. It is known that such a resolution would not be satisfactory to Senator Walsh and it is expected that he will attempt, on the floor of the Senate, to increase its scope.

Highways—Judging from the expressions of members of the committee on roads of the House of Representatives, now sitting in hearings on highway bills, the committee will recommend the authorization of $75,000,000 for federal aid for a period of two years. This continues the policy that has been in effect for several years. Efforts to increase the amount are being made, but there is little likelihood that they will be successful. It is not improbable, however, that the committee will recommend the use of $3,500,000 annually, for three years, for road construction through public lands. At present road construction in public land areas is lagging far behind the program elsewhere.

Regional Planning Progress in Chicago

The fifth annual meeting of the Chicago Regional Planning Association, Jan. 24, was attended by 400 persons, including the governor of Indiana, city officials, engineers, bankers, realtors, civic workers and others interested in the future of the region in Illinois, Wisconsin and Indiana within commuting distance of Chicago. Progress was evidenced by an elaborate map exhibit of population forecasts, location of industrial employees, zoning progress, highway continuity, open-space areas, probable future land use, sources of water supply and treatment of sewage. The association's population forecast for the region, including fifteen counties, was made public for the first time. For 1930 it is 5,040,000, for 1940 it is 6,282,000 and for 1950 it is 7,506,000, nearly double the 1920 census of 3,859,000.

Daniel H. Burnham was re-elected president, B. F. Affleck treasurer, and Robert Kingery secretary.

Annual Meeting of Indiana Engineering Society Covers Wide Variety of Subjects

State regulation of sanitary and other engineering projects was dealt with in some of the papers presented at the annual meeting of the Indiana Engineering Society, which was held at Indianapolis on Jan. 26 and 27 in conjunction with the local chapters of other societies. The program was arranged to cover numerous branches of engineering, but the number of papers was limited. That approval of all sewerage and water supply plans by the State Board of Health will be required after March 1, was explained by Lewis S. Finch, director of the state water and sewage department, and in the discussion this step was supported by S. C. Hadden as a result of his experience with a similar law in Kansas.

The work of the engineering division of the State Department of Conservation was outlined by Denzell Doggett, assistant state engineer. Its main duties include a stream-gaging program, a drainage survey of the state, study of the effect of drainage on groundwater levels in the Kankakee Valley, and examinations of drainage and flood-protection projects. Other work includes the design and construction of roads, bridges, water supply and sewage-works for the state parks, and investigating the alleged lowering of water level in the numerous lakes in Indiana. The efforts of the State Building Council to secure improvements in building codes was reviewed by L. W. Bruck, the society's representative in the council.

Activities at Purdue University were presented in two papers, Professor Crepps describing the progress on several major lines of investigation, and Professor R. E. Mills describing changes of volume in cement and in concrete beams as revealed in tests covering periods of 700 and 1,300 days. This investigation was almost the only subject to receive extended discussion.

Research Graduate Assistantships Open at Illinois

Two research graduate assistantships, under the patronage of the Illinois Gas Association, are announced in the Engineering Experiment Station of the University of Illinois. These are in addition to the fourteen already established. Appointments must be accepted for two consecutive collegiate years of ten months each, and at the expiration of that period the degree of master of science is conferred. Half the time of an appointee is required in connection with the department to which he is assigned, the remainder being available for graduate study.

Nominations, based on character, scholastic attainments and promise of success, are made from applications received by the director of the station not later than April 1.

Brief News

A Department of Agricultural Engineering has been established at the Ontario Agricultural College at Guelph, superseding the former departments of physics and manual training, with a view to teaching the farmers the advantages of modern machinery.

Erection of a Fireproof Hospital at the National Home for Disabled Volunteer Soldiers at Santa Monica, Calif., is proposed in a bill introduced into Congress by Representative Crail of California. This hospital would be erected on land now owned by the federal government and the cost would be limited to $1,500,000.

Presentation of the Washington Award for the year 1928 will be made to Dr. Michael Pupin on Thursday, Feb. 2, at a dinner to be given in the Palmer House, Chicago.

A Bridge or Tunnel, or both, over or under the East River, from a point in the Borough of Manhattan north of 59th St. to a point in the Borough of Queens, city of New York, is authorized in a bill introduced in the New York State Senate by Senator Thompson.

A Co-operative Course in Railroad Operation, combining scientific education at the Massachusetts Institute of Technology with fundamental training in modern transportation practice on the Boston & Maine Railroad, is announced by Dr. Samuel W. Stratton, president of the Institute. The course will include the fundamental subjects of civil and electrical engineering.

Options on Land in the Dundalk-Sollers Point section, on the waterfront, have been obtained by the city of Baltimore, which would be used for an airport. Bulkheads costing approximately $2,500,000 will have to be built to carry out the project. The bulkheading plans are to be worked out by Charles F. Goob, chief engineer of the city, and Bancroft Hill, formerly harbor engineer.

Award by the City of Montgomery, Ala., of a contract for two incinerators to the Superior Incinerator Company of Texas has been upheld by State Supreme Court on appeal from a like ruling by a lower court. The decisions resulted from a taxpayer's injunction suit based on the ground that another company, equally responsible had submitted a lower bid. The Supreme Court refused to pass on the relative merits of the incinerators offered by the two bidders.

The City Council of Minneapolis has voted against an offer of the American Feeding Company to dispose of the garbage of the city by feeding it to hogs, the city to deliver the garbage to a farm in Anoka County. N. W. Elsberg, city engineer, advised that the city would save little if anything by accepting the offer as compared with continuing incineration.

Browne Bill Would Give $407,341,145 to States For Road Construction

A bill authorizing the creation of a special highway fund, providing a total of $407,341,145 to be allotted among the states in the same proportion as the federal-aid funds authorized each year, has been introduced in the House by Congressman Edward E. Browne of Wisconsin. The bill providing for the utilization of this large sum is in addition to the federal-aid bill already introduced in both the House and the Senate.

The sum provided in the Browne measure is to be obtained by the payment of French bonds issued after the war covering an invoice of approximately $2,000,000,000 worth of property, including road-building machinery which in June, 1919, was ordered by the War Department to be turned over to the Agricultural Department to be proportioned among the states for use in highway construction. Bonds totaling $400,000,000 mature on Aug. 1, 1929, the remainder one year later.

Before the War Department's order for the return of the equipment was received in France, that country had bonded itself to pay for the material at approximately 20 cents on the dollar.

State Court Cannot Review Act of Water Commission

The right of superior courts to review the acts of the California State Water Commission in passing on applications to appropriate water was recently declared unconstitutional by the California State Supreme Court and that section of the state water act that specifies that superior courts have the right to review the acts and decisions of the State Water Commission, upholding or reversing them, was declared null and void. The State Water Commission is an administrative body of the state government, the Supreme Court held, and a judicial body such as a Superior Court has no legal right to review its acts except to determine whether its jurisdiction has been exceeded.

The matter was brought into court when the Water Commission granted the Mojave Irrigation District rights of appropriation on the Mojave River. Riparian owners protested and asked for a review by the Superior Court. The irrigation district petitioned the Supreme Court and secured a writ of prohibition preventing the Superior Court from granting the review.

The section of the state water act that is declared unconstitutional is Amendment 1-B, passed by the Legislature in 1923, which provides that "persons interested in any application for a permit to appropriate water may bring an action in the Superior Court for a review of the Water Commission's order within 30 days after the order is made."

Personal Notes

J. R. WEST, who has been in charge of the designing of piers, warehouses and transit sheds in the city of Seattle, has been appointed chief engineer of the port of Seattle and will soon be ready to submit to the Port Commission a comprehensive plan for the development of the Skinner & Eddy shipyard site.

A. B. MCDANIEL, consulting engineer and treasurer of the Research Service, Inc., has left for France to continue contract with the Tidal Power Syndicate. From France he will go to Egypt to see the director of public works, and thence to Palestine, where he is to look into some of the proposed developments of water power.

H. J. HARDER, who for the past three years as grade crossing engineer has represented the city of Paterson, N. J., under a contract with the Erie Railroad for the elimination of most of the grade crossings along that railroad within the Paterson city limits, has been appointed city engineer and will take over all municipal projects, including grade crossing elimination. He succeeds William Gavin Taylor, who was appointed city engineer and surveyor for a term of three years on Jan. 1, 1925. Mr. Harder was city engineer from 1900 to 1925, when he was transferred to grade-crossing work at his own request.

WILLIAM GAVIN TAYLOR and GERALD W. KNIGHT have formed an association, under the name of Taylor & Knight, for professional engineering work, with offices in the Military Park Building, Newark, N. J. Mr. Taylor has had long experience in the design, promotion and construction of public works, including the metropolitan water-works of Boston, the Passaic Valley sewer and the sewerage of Waterbury, Conn. He was for three years city engineer and executive officer of the Board of Public Works of Paterson, N. J., for which city he designed and constructed a high-temperature refuse-disposal plant. Mr. Knight has been identified with the Passaic Valley sewer since it was opened and is consulting engineer for the Intercounty Protective League in connection with Passaic River flood control.

Col. CHARLES L. POTTER has been retired for age from the Corps of Engineers but has been reassigned to temporary active service as head of the Mississippi River Commission and as division engineer of the Western Division, with headquarters at St. Louis, Mo.

J. M. PAGE, formerly State Highway Engineer of Oklahoma, who for the past six months has been executive secretary for the Texas Highway Branch, Associated General Contractors of America, with headquarters at Austin, now represents the Everlasting Paint & Sales Company, Inc., of Los Angeles, Calif., in the states of Texas and Oklahoma. Mr. Page will establish a district office at Austin, Tex.

Engineering Societies

Calendar

Annual Meetings

NATIONAL ASSOCIATION OF BUILDERS' EXCHANGES, Washington, D. C.; Annual meeting, Miami, Fla., Feb. 6-9, 1928.

ENGINEERING INSTITUTE OF CANADA, Montreal; Annual Meeting, Monday, Feb. 14-16, 1928.

ASSOCIATION OF HIGHWAY OFFICIALS OF NORTH ATLANTIC STATES, Trenton, N. J.; Annual Convention, Atlantic City, N. J., Feb. 15-17, 1928.

AMERICAN CONCRETE INSTITUTE, Detroit, Mich.; Annual Convention, Philadelphia, Feb. 28, 29 and March 1, 1928.

AMERICAN RAILWAY ENGINEERING ASSOCIATION, Chicago, Ill.; Annual Convention, Chicago, March 6-8.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION; Annual meeting, University of North Carolina, June 25.

THE IOWA ENGINEERING SOCIETY will hold its annual meeting in Waterloo on Feb. 8 and 9. Flood-control problems will feature the program of papers, which will include "A Survey of Iowa Floods," by Prof. Floyd A. Nagler; "Influence of Floods on Sewers and Sewage-Treatment Works," by W. E. Stanley; "A National Flood-Control Policy," by Prof. S. M. Woodward; "Flood Problems of Iowa Cities," a symposium by engineers representing Council Bluffs, Cedar Rapids, Decorah, Waterloo, Muscatine, Sioux City and Clinton. Other subjects include: "Draining the Everglades," by Dr. Anson Marston; "Maintenance of Roads in Iowa," by W. H. Root, and "Financing the Reconstruction of City Pavements," by P. F. Hopkins, city manager of Mason City. J. S. Dodds, of Ames, Iowa, is secretary of the society.

THE INTERNATIONAL ASSOCIATION OF STREET SANITATION OFFICIALS, at its recent annual meeting at Detroit, elected officers as follows: President, Theodore Eichorn, superintendent, department of streets and public improvements, Erie, Pa.; vice-presidents, Robert B. Brooks, director of streets and sewers, St. Louis, Mo.; Elmer C. Goodwin, examining engineer, department of street cleaning, New York, N. Y.; A. B. Cook, chief sanitary inspector, Charlotte, N. C.; treasurer, P. J. Hurtgen, director of public works, Kenosha, Wis. The secretary, re-elected, is A. M. Anderson, 10 South La Salle St., Chicago.

THE COLORADO SOCIETY OF ENGINEERS at its annual meeting in Denver on Jan. 21 elected the following officers: President, O. T. Reedy; vice-president, John E. Field; secretary-treasurer, C. M. Lightburn; directors, W. R. Hellyer, C. A. Betts, R. J. O'Rourke, W. B. Freeman, John Burgess, Robert Follansbee and George M. Bull.

Obituary

GODFREY EDWARDS, aged 54, senior member of Edwards, Wildey & Dixon, construction contractors, of Los Angeles, Calif., died at his home in Pasadena, Calif., on Jan. 23 of pneumonia. His firm erected the Shrine Auditorium, the Coliseum, the Fine Arts Building and other prominent structures in Los Angeles. The firm is now constructing the Sutherland dam for the city of San Diego.

Dr. WILHELM SCHACHENMEIER, professor of structural engineering at the Munich technical college, died on Nov. 20. He was known to many American bridge engineers, especially for his designs and writings in the field of suspension bridges. Born in 1882, he took up the teaching profession soon after graduating at Karlsruhe. Later he was engineer of the Gustarsburg plant of the Maschinenfabrik Augsburg-Nürnberg, and in this capacity was a prominent factor in the construction in 1915 of the self-anchored suspension bridge crossing the Rhine at Cologne. Since 1920 he occupied the Munich professorship, and in this period devised a suspension system of lateral bracing for suspension bridges.

FRED C. DUNLAP, 68 years old, newly appointed chief of the Philadelphia Bureau of Highways, died of pneumonia at his home in Philadelphia on Jan. 25. He had been in the service of the city, chiefly in the Water Bureau, more than twenty years. Mr. Dunlap was the engineer in charge of the construction of two of the city's filtration plants.

E. J. THOMAS, of D. D. Thomas & Son, building contractors, of Memphis, Tenn., and newly elected vice-president at large of the Associated General Contractors died suddenly early in the morning on Jan. 27 while in attendance at the annual convention of that association at West Baden, Ind. Mr. Thomas was in his usual health and spirits and attended the banquet on the preceding evening. He was taken ill during the night and died of heart disease. Mr. Thomas was born in Erin, Tenn., 49 years ago and moved to Memphis in his early youth with his father, David D. Thomas, a builder who established business in that city. Since his father's death, more than twenty years ago, he had been head of the buisiness, operating throughout the Southern states, with a branch office at Jacksonville, Fla. Mr. Thomas was one of the fourteen founders of the Associated General Contractors and had been one of its most active members, serving almost continually on the board of directors and on various standing committees.

Capt. FRANK O. MAXSON, Civil Engineer Corps, U. S. N., retired, died of pneumonia at his home in Coupeville, Wash., on Jan. 21. He was 76 years old. He was retired in August, 1913, after 32 years active service.

Construction Equipment and Materials

A Section Devoted to What the Manufacturer Is Doing for the Engineer and Contractor

Handbook on Reinforced-Concrete Construction

The Handbook on Reinforced-Concrete Construction, recently published by the Concrete Reinforcing Steel Institute, Chicago, contains much information of value to the architect and to the engineer. The booklet has been compiled from the best sources available and touches on the use of reinforced concrete in all of its various adaptations. All methods of construction outlined in the handbook are in accordance with the principles of the standard building regulations for reinforced concrete recommended jointly by the American Concrete Institute and the Concrete Reinforcing Steel Institute. Starting out with a story of the history of reinforced concrete, chapters are then devoted to the code of standard practice adopted by the institute and statements of building regulations recommended by the institute. Then follow chapters on design, including diagrams and tables, and on standard units of design, which include recommendations for simplification. The remaining chapters then are devoted to specifications for placing steel for reinforced concrete, for portland cement, and for the intermediate grade of billet steel, and for reinforcement bars respectively. A comprehensive subject index contributes to the usefulness of the book. The price of the book is $1.

Chain Crowd Shovels

In our Road Show report, *Engineering News-Record*, Jan. 19, 1928, p. 132, the power shovels exhibited by the Harnischfeger Sales Corporation, Milwaukee, were described as chain-driven machines. This should have read chain crowd machines, as all Harnischfeger power shovels and cranes are gear driven.

Business Notes

MANUFACTURERS' CATALOGS are wanted by the Miami, Florida, Builders Exchange to be placed on file in its library.

C. MARSHALL TAYLOR has been appointed vice-president and general manager of the Curtin-Howe Corporation, 11 Park Place, New York City, which holds the commercial rights to the new wood preservative developed by the engineering laboratories of the Western Union Telegraph Company. The preservative is zinc meta-arsenite and it is placed in the wood following standard processes now utilized in the wood preserving industry. It is claimed that the wood retains its natural color, can be used for all types of construction and can readily be painted.

A. A. LAZAREVSKY, chief engineer, new lines department, Soviet Commissariat for Transportation, and S. M. Ivanov, vice-president, Turkestan-Siberian Railway, are members of the Russian railway delegation that has arrived in the United States to purchase construction machinery. The Turkestan-Siberian line now under construction will be about 900 miles long and will connect the grain centers of Siberia with the cotton regions of Turkestan. The Commission plans to purchase such equipment as power shovels, pneumatic drills, dump cars and spare parts totaling more than a million dollars.

CAROLINA CEMENT COMPANY, recently organized, announces that it will commence the construction of a main mill building at New Bern, N. C., at an early date. According to the plans announced by J. A. Acker, president, the plant will represent an expenditure of approximately three million dollars and will have an initial rated capacity of 1,500,000 barrels a year. Mr. Acker is at present chief engineer of the New Egyptian Portland Cement Company, Michigan City, Mich. The new plant will be the first cement manufacturing plant in North Carolina.

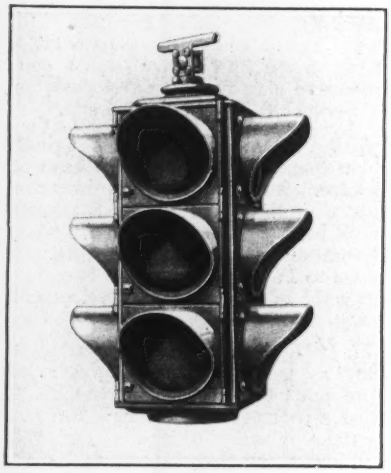
EDWARD L. RYERSON, chairman, board of directors, Joseph T. Ryerson & Son, Inc., Chicago, died at his home January 19 following a stroke of apoplexy. Mr. Ryerson was 73 years old. On his graduation from Yale University in 1876, he entered the iron and steel business of his father, Joseph T. Ryerson, and was made a partner in 1878. Since 1883 Mr. Ryerson has been at the head of the company, although in 1911 he retired from the presidency and became chairman of the board.

New Developments

New Electric Traffic Signal

A new stop-and-go signal of the all electric type embodying three lights, red, amber and green, and so constructed that it may be mounted either upon standards or suspended overhead from a cable or mast arm, has recently been developed by the Interflash Signal Corporation, 120 Broadway, New York City.

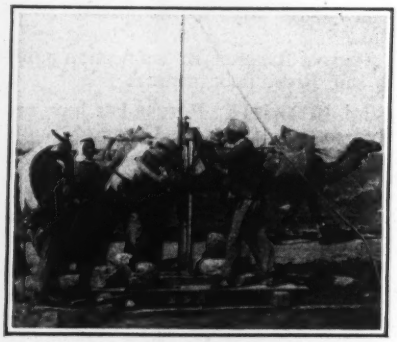
The housing of the signal is made of cast-aluminum alloy, as are the lens and reflector holders and sun visors. The lenses, 8⅜ in. in diameter, are used in connection with standard 60-watt traffic signal lamps inside of a



silvered polished glass reflector. Adjustments or replacements of lamps can be made by opening the section affected without in any way disturbing the operation of the signal.

Test Drilling for Dam Sites in Palestine

In the Jordan valley in Palestine, the Palestine Electric Corporation, Ltd., a British concern, has been prospecting for a series of electric power dams which it expects to construct along the course of the Jordan over a period of years. The accompanying illustration shows the test drilling under way, using a Sullivan Bravo hand power diamond drill. Some time after the picture was taken, early last year, a gasoline engine outfit was shipped to the drill, and thereafter the work proceeded more rapidly. Incidentally, the Sullivan Machinery Company toward the latter part of 1927 developed a new



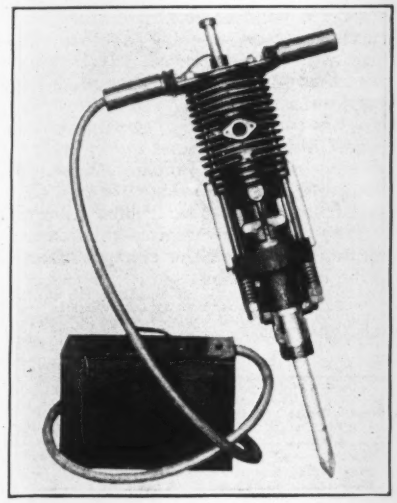
DIAMOND DRILLING ON DAM SITE IN PALESTINE

Bravo diamond-core drill on which changes have been made which are claimed to provide greater convenience and speed at a lower cost.

The operators shown in the picture were trained by one of the experts of the Compagnie Sullivan, the Paris organization of the Sullivan Machinery Company. Drill holes five to ten meters in depth were bored, removing a 1⅜-in. core. The rock encountered was basalt of varying hardness. The dam to be constructed will be 900 ft. long, forming a lake in the Yarmuc Valley. The hydro-electric generating station will be close to the outlet of the Yarmuc into the Jordan. The company has three electric stations in service, operated by Diesel engines at the present time.

Pavement Breaking With a Gasoline Hammer

A gasoline hammer to be used as a pavement breaker has recently been placed on the market by the Milwaukee Gas Tool Corporation, Milwaukee, Wis. It is claimed to be radically different from any other equipment now in use, using no flywheels, connecting rods, cam shaft or bearings. The piston operates as the hammer, striking more than 1,000 blows per minute. These blows are transmitted through an anvil

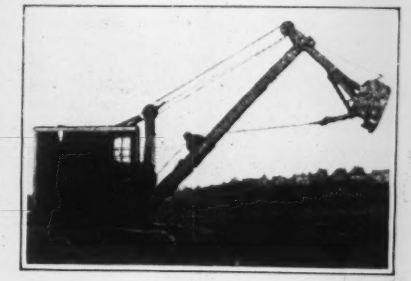


direct to any standard cutting tool which may be used.

The entire unit weighs but 85 lb., and it is claimed will operate all day on two gallons of gasoline. Further, it requires no outside equipment to operate, being a self-contained unit. The machine will be manufactured by the Le Roi Company, Milwaukee, Wis., for the Gas Tool Corporation and will be marketed through contractor equipment distributors.

Trench Hoe and Skimmer Scoop for ½-Yd. Excavator

The ½-cu.yd. excavator brought out by the Harnischfeger Corporation early in 1927 has been made adaptable for wider application by the addition of a new trench hoe and skimmer scoop. Both the hoe and skimmer booms are built of heavy I-beams, securely trussed and braced, all joints being electrically welded. The hoe can dig to a depth of 16 ft., and by shifting the course of the boom and bucket any width of trench can be cut. The hoe dipper is



shaped from heavy boiler plate and the seams are electrically welded.

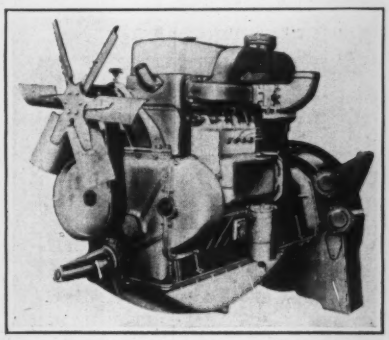
The skimmer scoop is constructed of heavy boiler plate and has a horizontal travel of 13 ft. Heavy spring bumpers are cast integral with the boom foot, thereby eliminating heavy jolts on the boom as the bucket rolls back to the machine.

New Light, High-Speed Diesel for Industrial Uses

Designed for application to power shovels, cranes, compressors, locomotives, dredges, pumps, hoists and similar equipment, the new Diesel engine of the Buda Company, Harvey, Ill., is claimed to incorporate all the latest developments in light-weight high-speed Diesel engine construction. The new engine is being manufactured under license from the M.A.N. Company in Germany, the original developers of the Diesel engine.

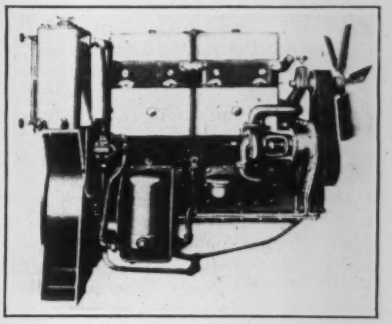
The present model is American built and is a 6x8-in. solid injection, four-cylinder four-stroke-cycle type, developing 92 b.hp. at a normal speed of 1,000 r.p.m. Fuel is injected into the combustion chamber by means of pressure from the fuel pumps without the use of compressed air or pre-combustion chambers. This compressorless construction is one of the main contributing reasons for the light weight.

Removable cylinder sleeves are used, and the cylinder heads are cast in pairs. Each cylinder is fitted with two injection nozzles, one on each side of the cylinder, such an arrangement claiming to make possible the largest area for intake valves. The fuel pump is driven by a gear in mesh with the timing gear



train, and independent fuel pumps for each cylinder are grouped in a common housing, delivering fuel in proportion to the load. A forced feed lubricating system is used. Electric starting motors or a two-cylinder air-cooled gasoline engine can be supplied for starting duty.

The upper illustration is a view of the fuel pump side showing the fuel filter, fuel dividers, and inlet and exhaust manifold with the elbow for air filter application. The lower illustration is a view of the water pump side of the same engine showing the lubricating oil tank with sight glass, the lubricating oil dual-geared type pump with piping and filter,



the crankcase breather, centrifugal water pump, removable push rod cover plates and cylinder head covers, and the nozzle clamps.

Manufacturers and Trade Associations

Calendar

Annual Meetings

NATIONAL BRICK MANUFACTURERS ASSOCIATION, Danville, Ill.; Annual meeting, Atlantic City, Feb. 8-12.

COMMON BRICK MANUFACTURERS ASSN., Cleveland; Annual meeting, Washington, Feb. 13-17.

CHICAGO POWER SHOW AND MID WEST ENGINEERING EXPOSITION, Chicago, Feb. 14-18.

New Publications

Cork Installation—UNITED CORK CO., New York City, has published a comprehensive booklet entitled "Facts and Figures on Installation." The booklet contains a description of cork and its uses, at the same time giving examples of the methods of installation under various conditions. Illustrations of many types of structures where cork board has been used are given. The special feature of the booklet is the inclusion of some 50 pages of detailed specifications showing practically every type of construction that may be employed in installing cork in old as well as in new buildings.

Business Side of Construction

Facts and Events That Affect Cost and Volume

Significant Changes During January in Contract Lettings

Commercial and Engineering Construction on the Decline—Probably a Temporary Condition

JANUARY construction contracts did not match the record hung up in December, but were higher than last January's figure. Private commercial building work has fallen off, though public buildings show an increase. The *Engineering News-Record* Construction Cost Index Number is 0.4 per cent higher than a month ago, due to a rise in steel prices, with a further advance looked for within a few months. Changes in skilled and common labor rates have been negligible. The rise in steel was perhaps the most significant change in the materials market. Two other important developments were a cut in Mid-Western cement quotations and checking of price decline in cast-iron pipe.

Contracts reported in January by *Engineering News-Record* total $197,984,000 or $49,500,000 per week, which is 35 per cent less than for the average December (the record) week, but 9 per cent more than the figure of January, 1927.

Increases over December are in water-works (low last year), excavation, public buildings and Federal Government work. There was a definite drop in lettings for private commercial buildings and for that important engineering division, "unclassified"—which includes tunnels, subways, wharves, pipe and transmission lines, and power developments. Awards in New England were about the same as in December, but elsewhere there was a uniform decrease of more than 20 per cent.

The 5 per cent increase in value of water-works contracted for in January as compared with the preceding month was due to large awards in the Middle West, where the total was $1,159,000 in January and only $124,000 in December, 1927. In spite of a general decrease in industrial building the states west of the Mississippi and in the Far West showed increases of 12 and 63 per cent respectively. Commercial buildings were contracted for in larger volume in New England and in the South. New York state contributed $65,740,000, or about 43 per cent of the total private commercial building awards in December, 1927, and in January only $24,955,000, which was 32 per cent of the total.

Five classes of construction increased over January, 1927. These increases in percentages are: bridges, 12; streets and roads, 10; Federal Government, 47; unclassified, 288; excavation, 493. The increase in excavation contracts is due less to unusual activity in current contract-letting than to subnormal conditions a year ago, when the total for the first month was only $603,000, the average month for the year being $3,500,000. January contracts in the unclassified division include the Michigan-Ontario international tunnel, $10,000,000, and several pipe lines in Texas totaling $10,000,000.

The sectional changes show increases over January, 1927, in all except the New England and Far Western states. The South increased 50 per cent; the Middle Atlantic, 41; West of Mississippi, 30; the Middle West less than 1 per cent. In the South the value of awards for commercial and public buildings in January, 1928, was 100 per cent greater than last year. Industrial buildings and unclassified showed the most appreciable increases in the Middle Atlantic group.

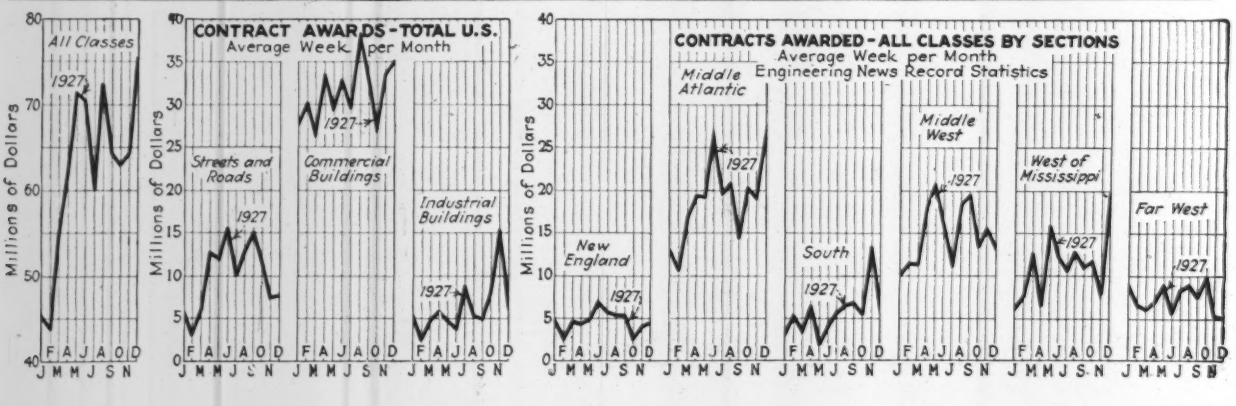
Cost Index Rises Slightly

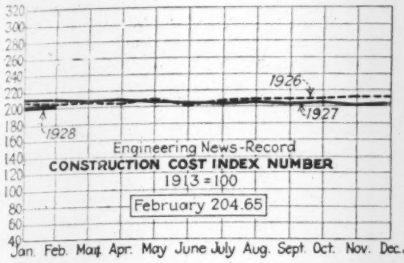
Cost—An advance of 5 cents per 100 lb. in structural shapes at Pittsburgh lifted the *E. N.-R.* Cost Index from the January figure of 203.90 to the current figure of 204.65—a rise of 0.4 per cent. The new steel price, $1.85, applies to deliveries during the first quarter, hence it is quite possible that with the construction season opening another advance will be announced. It is suggested that $2 may be the base price for second-quarter orders. With the other factors in the Cost Index remaining unchanged, this would boost the figure 2.2 per cent over the January value, to 208.40, the highest since April, 1927. Aside from a negligible decline ($\frac{1}{4}$ cent per hour) in the average common-labor rate, there were no other changes affecting the index number.

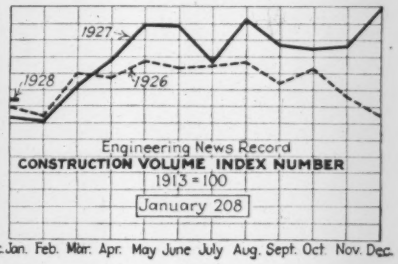
VALUE OF CONTRACTS BY SECTIONS IN THE UNITED STATES—JANUARY, 1928

Thousands of dollars (–000 omitted)

	New England	Middle Atlantic	South	Middle West	West of Mississippi	Far West	Total United States	Total United States January, 1927	Canada
Waterworks	$60	$328	$150	$1,159	$187	$263	$2,147	$2,680	$30
Sewers	147	677	.....	1,394	152	701	3,071	4,697	62
Bridges	17	895	1,804	552	1,237	156	4,661	4,161	750
Excavation, drainage, etc.	.....	42	1,945	150	72	770	2,979	603	.....
Streets and roads	1,744	1,893	6,947	5,345	8,188	2,664	26,781	24,235	.....
Industrial buildings	1,050	11,178	498	4,031	2,940	1,318	21,015	21,578	600
Commercial buildings	13,858	42,631	6,718	20,342	4,623	7,817	78,140	111,285	5,485
Federal government	.....	2,195	112	767	428	2,113	5,615	3,825	.....
Unclassified	431	12,965	903	6,536	13,854	1,000	35,722	8,678	5,648
Total, January, 1928	$17,340	$72,804	$19,077	$40,280	$31,681	$16,802	$197,984	.....	12,575
Total, December, 1927	21,650	134,125	30,049	66,727	99,950	25,343	377,844	.....	51,076
Total, January, 1927	18,525	51,381	12,716	40,104	24,441	34,573	.....	181,740	5,028







Volume—The *E. N.-R.* Construction Volume Index is 208 for January compared with 319 (the record) in December; but it is 11 per cent higher than the figure of January, 1927.

E. N.-R. Cost Index		E. N.-R. Volume Index	
February, 1928	204.65	January, 1928	208
January, 1928	203.90	December, 1927	319
February, 1927	210.15	January, 1927	187
Peak, June, 1920	273.80	1927 (average)	263
1927 (average)	206.24	1926 (average)	228
1926 (average)	208.03	1913	100
1927		**1927**	
January	211.50	January	187
February	210.15	February	182
March	208.80	March	226
April	209.00	April	257
May	206.80	May	299
June	205.55	June	297
July	203.68	July	252
August	205.50	August	306
September	203.60	September	273
October	204.40	October	269
November	201.98	November	272
December	203.90	December	319

Less Employment Due Chiefly to Winter Season

Out of twenty-three industries reporting employment conditions, seventeen say slowing-down. These, however, are in the group whose activity depends to a large extent upon the weather—as lumbering, agriculture, leather, food—and upon demand from such industries as are stimulated by construction at full tilt: iron and steel, cement, clay products, glass and electrical goods. Increasing unemployment is reported also by makers of musical instruments, paper, textiles and chemicals.

The six industries which report recruiting are: (1) automotive; (2) rubber; (3) agricultural implement; (4) pottery; (5) printing; (6) meat packing. Activity in the last named pursuit is interesting in view of decreased employment in the production of food products other than meats.

An authority says: "the usual post-holiday excess of unskilled laborers and clerical workers is in evidence in the principal cities." Boston reports 50,000 unemployed, the highest in thirteen years; San Francisco says its unemployment is the worst since 1921. Other cities report as follows:

Toronto plasterers are returning in appreciable numbers from New York, Chicago, Detroit, and other cities in the United States, where work had been plentiful in this trade for the last four years. Tile setters, marble and terrazo workers are on strike in the Toronto district. The tile setters demand an increase of 15c. per hr. over the 1927 rate of $1.10.

Chicago plasterers' union signed an agreement in January, with the Employing Plasterers' Association, to continue the five-day week plan for the next three months. The lathers' union is working for a similar arrangement. It is stated, however, that the unions will not permit men to make overtime by working on Saturdays. Landis Award contractors went on record as opposing the five-day plan. Conditions are particularly bad among carpenters in Chicago. A contractor who a few days ago advertised for five carpenters was confronted by three hundred applicants.

Cleveland bricklayers signed a two-year agreement with employers at the 1927 rate of $1.62½ per hour.

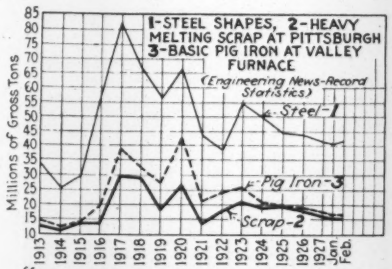
St. Louis cement finishers demand the five-day week, effective Apr. 1; carpenters, May 1, 1928. Employers' organizations have formally protested against both proposals.

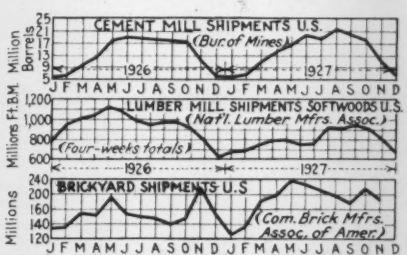
Denver bricklayers and structural iron workers are largely unemployed at present. Demand for carpenters, however, continues brisk. The Amarillo-

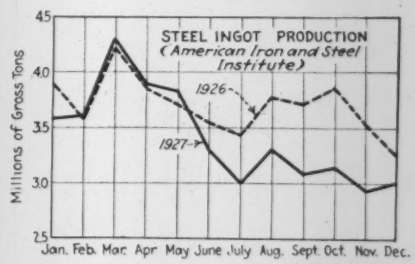
CURRENT BUILDING TRADES WAGE RATES PER HOUR

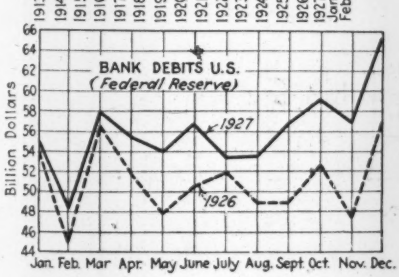
(Higher rates than a month ago indicated by +, decreases by —)

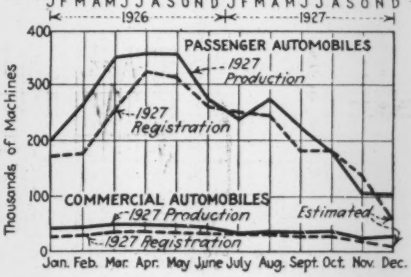
Cities	Bricklayers	Carpenters	Hoisting Engineers	Hod Carriers	Pile Drivers	Structural Iron Workers	Common Labor
Atlanta	$1.40	$0.70	$0.70	$0.50	.....	$0.75	$0.25@.30
Baltimore	1.62½	1.00 @1.10	1.00 @1.37½	1.00	$0.65	—1.00@1.25	.35
Birmingham	1.00@1.50	1.05	1.00	.50 @ .75	.....	1.75	.25@.40
Boston	1.40	1.25	1.25	.79	1.15	1.25	.45@.74
Cincinnati	1.50	1.37½	1.37½	.97½	1.37½	1.37½	.45@.60
Chicago	1.62½	1.50	1.00 @1.50	.90 @ .96¼	1.50	1.50	.90
Cleveland	1.62½	1.37½	1.37½	.87½	1.10	1.50	.87½
Dallas	1.62½	1.12½	1.00	.40 @.75	1.00	1.25	.30 @.50
Denver	1.50@1.62½	1.25	1.25 @1.37½	.87½@1.00	.....	1.25	.31¼@.50
Detroit	1.56¼	1.00 @1.25	1.00 @1.10	.90	1.00@1.10	1.00@1.25	.50 @.60
Kansas City	1.50	1.25	1.25	.90	1.25	1.25	.35 @.75
Los Angeles	1.37½	1.00	1.00	.81¼	1.12½	1.00	.50
Minneapolis	1.25	.87½@ .95	.87½	.75	.....	1.00	.45 @.60
Montreal	—1.12	.75	.75	.45	.50	—.75	.30 @.35
New Orleans	1.50	.90	1.25	.75	.80@1.00	1.25	.30 @.40
New York	1.75	1.50	1.75	1.12½	1.00@1.12½	1.75	.90¼
Philadelphia	1.62½	1.12½@1.25	1.02½	.70 @1.12½	1.00	1.37½@1.50	.45 @.50
Pittsburgh	1.70	1.50	1.37½@1.50	1.12½	.....	1.50	.50 @.80
St. Louis	1.75	1.50	1.50 @1.65	1.15 @1.25	1.25	1.50	.45 @.75
San Francisco	1.37½	1.12½	1.00 @1.12½	1.00	—1.00@1.12½	—1.12½@1.25	.50 @.60
Seattle	1.37½	1.12½	1.00 @1.12½	1.00	1.00@1.12½	1.12½@1.25	62½.@ 70

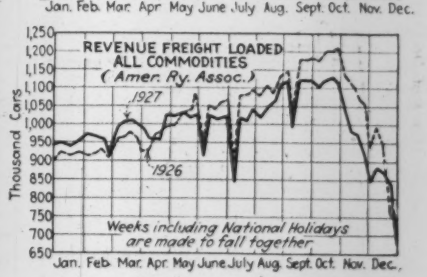

1-STEEL SHAPES, 2-HEAVY MELTING SCRAP AT PITTSBURGH
3-BASIC PIG IRON AT VALLEY FURNACE
(Engineering News-Record Statistics)
Steel-1
Pig Iron-3
Scrap-2
Millions of Gross Tons
1913 1914 1915 1916 1917 1918 1919 1920 1921 1922 1923 1924 1925 1926 1927 Jan. Feb.


CEMENT MILL SHIPMENTS U.S.
(Bur. of Mines)
Million Barrels
1926
1927
LUMBER MILL SHIPMENTS SOFTWOODS U.S.
(Nat'l. Lumber Mfrs. Assoc.)
(Four-weeks totals)
Millions Ft. B.M.
BRICKYARD SHIPMENTS U.S.
(Com. Brick Mfrs. Assoc. of Amer.)
Millions
J F M A M J J A S O N D J F M A M J J A S O N D


STEEL INGOT PRODUCTION
(American Iron and Steel Institute)
1926
1927
Millions of Gross Tons
Jan. Feb. Mar. Apr. May June July Aug. Sept. Oct. Nov. Dec.






REVENUE FREIGHT LOADED
ALL COMMODITIES
(Amer. Ry. Assoc.)
1927
1926
Thousand Cars
Weeks including National Holidays are made to fall together
Jan. Feb. Mar. Apr. May June July Aug. Sept. Oct. Nov. Dec.

Denver pipe line is absorbing part of the great excess of common laborers.

Detroit reports increasingly active employment of building laborers and automobile mechanics.

Several actual wage reductions occurred during the month, as noted in the table on p. 215. Structural iron workers' open-shop rate in Baltimore is down 20c., to $1 per hr. Montreal maximum for this trade is now 75c., against 90c. per hr. last month. In San Francisco the range is $1.12½ to $1.25 per hr., compared with $1.37½ one month ago.

Bricklayers at Montreal were reduced during January to $1.12 per hr. from $1.25. Men in this craft at Minneapolis receive a maximum of $1.25 as against $1.37½ per hr. last month.

Pile drivers' wages in San Francisco range from $1 to $1.12½ per hr., while a month ago a uniform rate of $1.12½ prevailed.

Materials Prices Below Year Ago

The trend in prices of building materials as a group has been definitely downward since January, 1927, with the exception of slight upturns which occurred in May and December, last year. Present levels show little change from those of January since advances and declines practically balanced. The general level, however, is about 8 per cent below that of a year ago.

The current Volume Index (208) shows that demand is 11 per cent greater than at the beginning of this period of price decline. See index numbers of contract volume on p. 215.

Steel—The upward trend of fabricated structural steel sales justifies the advance, Jan. 19, of $1 per ton on the principal hot rolled steel products at mills. See chart at bottom of page. Structural bookings in 1927 gained 7.8 per cent over 1926 and are still in increasingly large volume. Aside from the influence of a gain in sales, the two advances since November were designed to check price cutting that had characterized the first eleven months of 1927. The upward movement of steel prices is also accompanied by active buying of railway and agricultural implement material, black and galvanized sheets, bolts, nuts and rivets. Mill operations are at 78 per cent of capacity, the same as at this time last year. Surplus pig iron stocks are decreasing gradually at Southern yards, with consequent firmness of prices. Current sales of bars, plates, and shapes, base, Pittsburgh, are at $1.85 per 100 lb. in carloads, against $1.80 in December and January, and $1.75 in November. Reinforcing bars in less-than-carload lots bring as high as $1.95 per 100 lb., Pittsburgh.

Lumber—Prices are easier with present levels, all sizes and species, slightly less than 2 per cent below those of a month ago. Orders at 477 mills for the week of Jan. 21 were 118 per cent of the cut for that period. If demand continues in its present ratio to production, prices will advance.

Cement—A move to stimulate winter construction in the Detroit district, one of the few active industrial centers at the present time, is seen in the reduction of 10c. per bbl. in the mill price of cement at Wyandotte, Mich., effective Jan. 18. The price, f.o.b. Detroit, in carloads to contractors, is $1.90 per bbl., net, against $2, a month ago. San Francisco also had a 10c. decline in January. Prices at the remaining forty-three mill and f.o.b. points reporting regularly to *E. N.-R.* hold at January levels. Dealers in domestic cement at New Orleans are deducting 20c. per bbl. from the delivered price, in order to meet competition from foreign shippers on city paving jobs. Total imports are running at about 178 per cent of exports and 1.2 per cent of shipments from American mills to domestic consumers. Over 71 per cent of the foreign cement now coming in is from Belgium. The rest comes from Canada, France, Germany, Norway and the United Kingdom. States taking the bulk of the foreign cement are: California, Florida, Maine, Massachusetts, New Hampshire, New York, Pennsylvania, South Carolina and Texas.

Brick—Conditions differ in four of the greatest brick consuming districts of the nation. The New York market holds at the January advance of $1, to $14 per M, wholesale. Chicago prices are at year-ago levels, with no appreciable change in twelve months. A spurt in brick building construction caused an advance of $1 per M at New Orleans during the month, while an exceptionally dull market in Philadelphia resulted in a decline of $1.

Cast-Iron Pipe — Prices at Burlington, N. J., and New York remain unchanged, with the mill base $35 per net ton for 6-in., Class B. The Birmingham base, however, advanced in January to $28 from $27.50. This increase affects quotations f.o.b. Pittsburgh, Chicago, St. Louis and San Francisco.

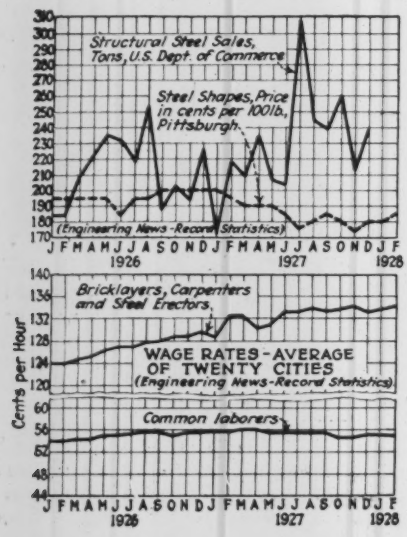
Sewer Pipe—The advance of 6 per cent in February prices at Pittsburgh, over those of the month preceding, presages similar increases, later, in other cities shown in the table on p. 217. This prediction is based on present low stocks at mills in sizes 6- to 24-in. inclusive.

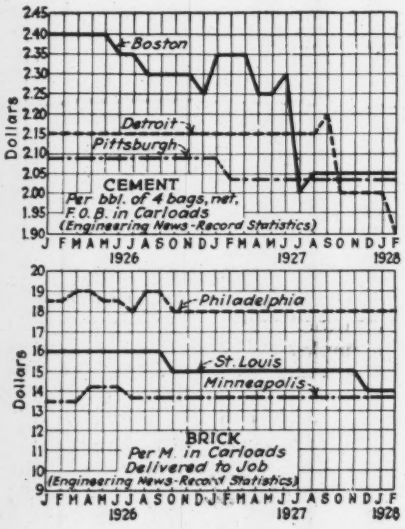
Lime—Southern lime dropped $1 per ton on hydrated finishing in Atlanta. The Boston market is off 50c. per ton on the same material, compared with the January price. Both changes are seasonal.

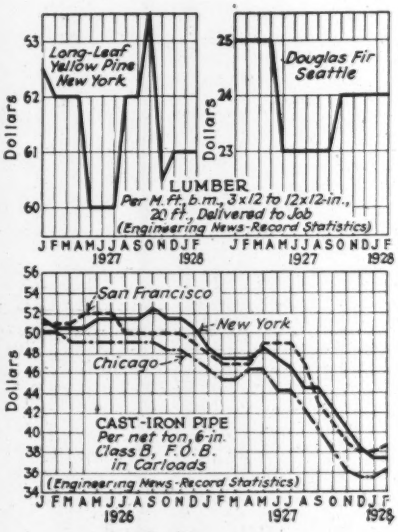
Manila Rope — A downward movement in the market is seen in the declines, during January, of 1¼c. per lb. at Chicago, Minneapolis, Denver and Kansas City, Mo.

Scrap — Following the advance in steel, heavy melting material is up 50c. per ton at New York. This movement, however, has not yet reached Chicago and Pittsburgh.

Other Materials—Steel rails hold at the $43 per ton base, Pittsburgh, established in October, 1922. Steel pipe and tin plate are practically in a class with rails, in that they have shown only one price decline each, since April, 1923. Minor materials, in the aggregate, are about one per cent above month ago levels and 7.5 per cent below prices as of this time last year.


Structural Steel Sales, Tons, U.S. Dept. of Commerce
Steel Shapes, Price in cents per 100lb., Pittsburgh
(Engineering News-Record Statistics)
Bricklayers, Carpenters and Steel Erectors
WAGE RATES-AVERAGE OF TWENTY CITIES
(Engineering News-Record Statistics)
Cents per Hour
Common laborers
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F
1926
1927
1928


Boston
Detroit
Pittsburgh
CEMENT
Per bbl. of 4 bags, net, F.O.B. in Carloads
(Engineering News-Record Statistics)
Dollars
Philadelphia
St. Louis
Minneapolis
BRICK
Per M. in Carloads Delivered to Job
(Engineering News-Record Statistics)
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F
1926
1927
1928


Long-Leaf Yellow Pine New York
Douglas Fir Seattle
LUMBER
Per M. Ft. b.m., 3x12 to 12x12-in., 20 Ft., Delivered to Job
(Engineering News-Record Statistics)
Dollars
San Francisco
New York
Chicago
CAST-IRON PIPE
Per net ton, 6-in. Class B, F.O.B. in Carloads
(Engineering News-Record Statistics)
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F
1926
1927
1928

E. N.-R. Prices of Construction Materials

Price advances since last month are indicated by **heavy type**; declines by *italics*

PIG IRON—Per gross ton, f.o.b.:

CINCINNATI	Feb. 2	One Year Ago
No. 2 Southern (silicon 2.25@2.75)	$21.44	$22.19
Northern Basic	20.89	20.89
No. 2 Southern Ohio (silicon 1.75@2.25)	21.39	21.39
NEW YORK, tidewater delivery		
Southern No. 2 (silicon 2.25@2.75)	25.62	26.37
BIRMINGHAM		
No. 2 Foundry (silicon 2.25@2.75)	16.00	18.50
PHILADELPHIA		
Eastern Pa., No. 2X (2.25@2.75 sil.)	21.76	23.26
Virginia No. 2 (silicon 2.25@2.75)	27.17	28.17
Basic	21.26	21.76
CHICAGO		
No. 2 Foundry Local (silicon 1.75@2.25)	20.00	21.00
No. 2 Foundry Southern (silicon 2.25@2.75)	22.80	24.55
PITTSBURGH, including freight charge ($1.76) from the Valley		
No. 2 Foundry Valley (silicon 1.75@2.25)	20.26	20.26
Basic	19.26	19.76
Bessemer	21.26	21.26

SCRAP—The prices following are f.o.b. per ton paid by dealers:

	New York	Chicago
No. 1 railroad wrought	$10.50@$11.00	**$11.00@$11.50**
Stove plate	*8.75@ 9.00*	**12.25@ 12.75**
No. 1 machinery cast	*12.50@* 14.00	14.00@ 14.50
Machine shop turnings	**6.75@** 7.50	7.50@ **8.00**
Cast borings	6.75@ 7.25	9.00@ 9.50
Railroad malleable	10.00@ 10.50	11.25@ 11.75
Re-rolling rails	10.50@ 11.00	13.00@ 13.50
Re-laying rails	23.00@ 24.00	.....
Heavy melting steel	**6.75@** 10.75	11.00@ 11.50
Iron and steel pipe	8.75@ *9.00*	.....

Railway Supplies

STEEL RAILS—The following quotations are per gross ton f.o.b. for carload or larger lots. For less than carload lots 5c. per 100 lb. is charged extra:

	Pittsburgh		Birmingham	Chicago	St. Louis
	Feb. 2	One Year Ago			
Standard bessemer rails	$43.00	$43.00	$43.00	$43.00	.....
Standard openhearth rails	43.00	43.00	43.00	43.00	$49.50
Light rails, 8 to 10 lb.	.....	.....	34@36	1.80@1.90*	1.85*
Light rails, 12 to 14 lb.	.....	.....	34@36	1.80@1.90*	1.765*
Light rails, 25 to 45 lb.	36.00	36.00	34@36	1.80@1.90*	1.72*
Re-rolled rails	30@*32*	30@32	34@36	34@36	.....

*Per 100 lb.

RAILWAY TIES—For fair-sized orders, the following prices per tie hold:

	6 In. x 8 In. by 8 Ft.	7 In. x 9 In. by 8½ Ft.
Chicago, white oak, plain	$1.40	$1.78
Chicago, empty cell creosoted	1.80	2.40
Chicago, zinc treated	1.60	2.10
San Francisco, green Douglas fir	.84	1.14
San Francisco, empty cell creosoted, Douglas fir	1.70	2.25
St. Louis, white oak, plain	1.25	1.50
St. Louis, zinc treated	1.65	1.90
St. Louis, red oak, plain	1.15	1.40
St. Louis, sap pine-cypress	.95	1.20
Birmingham, white oak	1.25	1.45

TRACK SUPPLIES—The following prices are base per 100 lb. f.o.b. Pittsburgh mill for carload lots, together with the warehouse prices at the places named:

	Pittsburgh			St. Louis	San Francisco	Birmingham
	Feb. 2	One Year Ago	Chicago			
Standard spikes, ⅝-in. and larger	$2.70@2.80	$2.80@2.90	$3.55	$3.65	$3.85	$3.00
Track bolts	3.80	3.90@ 4.25	4.55	4.65	5.35	3.90
Standard section angle bars, splice bars or fish plates	2.75	2.85	3.40	4.25	4.25	2.95
Tie plates	2.25	.....	....	....	....	....

Pipe

WROUGHT STEEL AND IRON PIPE—The following discounts from list are to jobbers for carload lots at Pittsburgh mill:

BUTT WELD

Inches	Steel Black	Steel Galv.	Inches	Iron Black	Iron Galv.
1 to 3	62	50½	1 to 1½	30	13
LAP WELD					
1	55	43½	2	23	7
2½ to 6	59	47½	2½	26	11
7 and 8	56	43½	3 to 6	28	13
9 and 10	54	41½	7 to 12	26	11
11 and 12	53	40½			

BUTT WELD, EXTRA STRONG, PLAIN ENDS

1 to 1½	60	49½	1 to 1½	30	14
2 to 3	61	50½			
LAP WELD, EXTRA STRONG, PLAIN ENDS					
2	53	42½	2	23	9
2½ to 4	57	46½	2½ to 4	29	15
4½ to 6	56	45½	4½ to 6	28	14
7 and 8	52	39½	7 and 8	21	7
9 and 10	45	32½	9 to 12	16	2
11 and 12	44	31½			

WROUGHT-STEEL PIPE—From warehouses at the places named the following discounts from list, hold for welded steel pipe:

	Black		
	New York	Chicago	St. Louis
1 to 3 in. butt welded	53%	54%	49%
2½ to 6 in. lap welded	48%	51%	46%
	Galvanized		
	New York	Chicago	St. Louis
1 to 3 in. butt welded	39%	41%	36%
2½ to 6 in. lap welded	35%	38%	33%

Malleable fittings, Classes B and C, banded, from New York stock sell at list plus 4% less 5%. Cast iron, standard sizes, 36—5% off.

CAST-IRON PIPE—The following are prices per net ton for Class B and heavier, f. o. b., in carload or larger lots:

	Birmingham	Burlington, N. J.	New York		
			Feb. 2	One Year Ago	
4 in.	**$31.00**	$38.00	$40.60	$51.60	
6 in. and over	**28.00**	35.00	37.60	47.60	
	Pittsburgh	Chicago	St. Louis	San Francisco	
4 in.	**$39.50**	**$39.20**	**$36.60**	**$42.00**	
6 in. and over	**36.50**	**36.20**	**33.60**	**39.00**	

Gas pipe and Class "A," $3.00 per ton extra.

CLAY DRAIN TILE—The following prices are per 1,000 lin.ft.:

	New York					
Size, In.	Feb. 2	One Year Ago	St. Louis	Birmingham	San Francisco	Dallas
3	$45.00	$45.00	$35.00	$45.00	.....	$73.00
4	56.00	55.00	35.00	56.00	$76.50	90.00
5	.....	.....	.....	80.00	97.75	118.00
6	90.00	90.00	65.00	100.00	127.50	150.00
8	150.00	160.00	150.00	165.00	212.50	210.00

SEWER PIPE—The following prices are in cents per foot for standard pipe in car load lots, f.o.b., except as otherwise stated:

Size, In.	New York Delivered	Pittsburgh	Birmingham	St. Louis	Chicago	San Francisco	Dallas
3	.....	**$0.075**	$0.10	.....	$0.088	$0.12	.....
4	.....	**.075**	.10	*$0.0875*	.088	.15	$0.15
5	.....	**.1125**	.135	.....	.11	.18	.18
6	$0.22	**.1125**	.21	.1225	.11	.21	.21
8	*.35*	**.175**	.315	.20	.18	.30	*.325*
10	*.48*	**.2625**	.45	.28	.2625	.42	*.476*
12	*.61*	**.3375**	.54	.36†	.3375	.56	.70
15	*1.03†*	**.45**	.75	.60†	.45	.92	*1.01*
18	*1.50†*	**.625**	.90	.84†	.875†	1.32	1.32
20	*1.80†*	**.75**	1.20	.....	1.05†	.....	.....
21	.....	**.875**	.....	1.12†	1.225†	.....	.....
22	*2.40†*	**1.00**	1.35	.....	1.40†	.....	*1.564*
24	*2.70†*	**1.125**	2.665	1.44†	1.575†	2.16	2.27
27	4.62†	**2.405**	2.952	2.45†	2.75†	3.00	3.34
30	5.12†	**2.664**	3.96	3.00†	3.75†	3.60	4.06
33	6.93†	*3.78*	4.51	3.55†	4.50†	.....	4.99
36	7.91†	*4.205*	5.06	3.95†	5.00†	.....	5.42

	3	5	8	12	24	30
Boston	$0.125	$0.175	$0.25	$0.47	$1.80†	$5.00†
Minneapolis	.....	.....	.25	.45	1.50	4.56
Denver	.135*	.18*	.27	.47	1.70	.....
Seattle	.14	.....	.35	.63	2.52	.....
Los Angeles	1675	.186	.2825	.5085†	2.034†	.....
New Orleans	.11*	.165*	.275	.4675	1.7875	3.50
Cincinnati	.105	.1575	.245	.4725	1.575	4.715
Atlanta	.10*	.15*	.25	.425	1.625	.....
Detroit	.081	.122	.189	.405	2.07†	4.715†
Baltimore	*.087*	*.1305*	*.203*	*.3915*	*1.305*	*4.725*
Kansas City, Mo.	.15*	.21	29	.52	1.90†	*3.60†*
Philadelphia	.10	.14	.235	.38	1.33	3.32

*4-in., 6-in., 9-in., respectively. †Double Strength.

Road and Paving Materials

ROAD OILS—Following are prices per gal. in tank cars, 8,000 gal. minimum f.o.b., places named:

	Feb. 2	One Year Ago
New York, 45% asphalt (at terminal)	$0.0725@$0.075	$0.065@$0.075
New York, 65% asphalt (at terminal)	.0675@ .0725	.0675@.0725
New York, binder (at terminal)	.07 @ .075	.07 @.075
New York, flux (at terminal)	.07 @ .075	.07 @.075
New York, liquid asphalt (at terminal)	.07 @ .075	.07 @.075
St. Louis, 40@50% asphalt	.052	.0503
St. Louis, 50@60% asphalt	.0554	.0523
Birmingham, 55% asphalt	.0475	.0475
Dallas, 45% asphalt	.0495	.0495
Dallas, 50% asphalt	.0455	.0455
Dallas, binder	.061	.061
San Francisco, binder, per ton	12.00*	12.00*

* F.o.b. Oleum, Cal. Freight to San Francisco, 80c. per ton.

E. N.-R. Prices of Construction Materials

ASPHALT—Price per ton in packages (350-lb. bbls. or 425-lb. drums) and in bulk in carload lots, f.o.b. points listed:

	Package	Bulk
New York (*Texas*)	$24.50	
Boston (*Mexican*)	24.00	$19.00
Chicago (*Texas*)	24.00	18.50
San Francisco, *f.o.b. refinery*, Oleum, Cal.	18.00	12.00
Dallas (*Texas*)	27.10	21.10
Seattle, "*D*" *grade, California, f.o.b. Richmond*	19.50	13.50
Denver (*California*)	24.00	
Minneapolis, *f.o.b. Twin Cities (Standolind)*	28.10	22.10
St. Louis (*Mexican*)	26.00	23.00
Baltimore (*Standard Oil*) (*f.o.b. refinery*)	22.50	18.50
Montreal (*Imperial*)	28.00	*21.50*
Atlanta (*Mexican*)	24.40	19.40
Detroit (*Mexican*)	24.00	19.00
Cincinnati (*Kentucky Rock*)		11.65
Maurer, N. J. (*Bermudez*)	30.00	
Maurer, N. J. (*Trinidad*)	23.00	
Philadelphia (*Mexican*)	20.00	18.00
Kansas City, Mo. (*Texas*)	28.30	24.30
Los Angeles ("*D*" *grade, California*)	*18.00	*12.00
Birmingham (*Mexican*)	27.00	21.00
New Orleans (*Mexican*)	20.00	17.00

*F.o.b. El Segundo Refinery. Drums used in New York.

NOTE—Barrels or drums are optional in most cities. About 6 bbls. to the ton, and from 4 to 5 drums; 200 to 300 gal. to the ton.

PAVING STONE—

New York (grade I)	5-in. granite, 30 blocks per sq.yd.	$150.00 per M.
San Francisco	Basalt block 4x7x8	70.00 per M.
Chicago	about 5x8x5 dressed	3.60 per sq.yd.
	about 5x8x5 common	3.25 per sq.yd.
Boston	5-in. Granite	135.00 per M.
Atlanta	Granite	2.50 per sq.yd.
Detroit	5-in. Granite	3.00 per sq.yd.
Baltimore	Granite	2.85 per sq.yd.
Montreal	Granite	104.75 per M.
New Orleans	Granite, 4x8x4	2.75 per sq.yd.
Cincinnati	Granite	135.00 per M.
St. Louis	Granite, 4x8x4	1.65 per sq.yd.
Kansas City	Granite	*2.40 per sq.yd.
Philadelphia	Granite	3.90@4.25 per sq.yd.
Minneapolis	Sandstone	2.74 per sq.yd.

FLAGGING—

New York	Bronx, 4 ft. wide	$0.24 per sq.ft.
	Manhattan, 4 ft. wide	24 per sq.ft.
	Queens, 5 ft. wide	26 per sq.ft.
	6x24-in. cross-walk	1.30 per lin.ft.

CURBING—*New York*: Bluestone, per lin.ft., f.o.b. barge, New York, 5x16 in., 90c. *St. Louis*: Class "A" straight, delivered, 5x18 in., 90c. per lin.ft.; roundings, $1.55 per lin.ft. *Birmingham*: Limestone, 5x18-in., $1.05 per lin.ft.

WOOD BLOCK, PAVING—

	Size of Block	Treatment	Per Sq. Yd.
New York	3	16	$2.40
New York	3½	16	2.70
Boston	3½	18	**2.45**
Chicago	4	16	2.25
Chicago	3½	16	2.10
St. Louis	3½	16	2.30
St. Louis	4	16	2.55
Seattle	4	16	Off market
Minneapolis	3½	16	2.50
Atlanta	3½	16	2.00
New Orleans	3	16	2.20
New Orleans	3½	16	2.30
New Orleans	4	16	2.40
Dallas	4	18	3.90
Baltimore	3½	16	None used
Montreal	4	16	4.50
Detroit	3	16	1.94
Cincinnati	3½	16	2.35
Kansas City	4	16	2.50
Philadelphia	4	16	None used

Construction Materials

SAND AND GRAVEL—Prices are for truckload lots to contractors, per cu.yd. Weight of sand, 1½ tons per cu.yd.; gravel, 1½ tons per cu.yd. unless otherwise specified in pounds.

	Gravel				Sand	
	1½ In.		¾ In.			
	Feb. 2	One Year Ago	Feb. 2	One Year Ago	Feb. 2	One Year Ago
New York (*alongside dock*)	$1.75	$1.75	$1.75	$1.75	$1.00	$1.00
Denver (*2,700*)	1.50	1.90	1.50	1.90	.75‡	1.00
Chicago	2.75†	1.85	2.75†	1.85	2.75†	1.56
St. Louis	1.45*	1.45*	1.45*	1.45*	1.20*	.83‡*
Seattle (*3,200*) (*2,850*)	1.00	1.25	1.00	1.25	1.00	1.25
Dallas	2.38	2.38	2.38	2.38	2.00	2.00
Minneapolis (*2,800*)	1.25*	1.65*	1.25*	1.65*	1.25†	1.25†
Cincinnati	1.30*	1.30*	1.30*	1.30*	1.05*	1.05*
San Francisco (*2,800*)	1.80	1.80	1.80	1.80	1.40	1.40
Boston (*on trucks at dock*)	1.75*	1.75*	1.75*	1.75*	1.25*	1.25*
New Orleans (*2,700*) (*2,500*)	1.95*	2.10*†	1.95*		1.40*	1.80
Los Angeles	2.10*†	1.95*	2.10*†	1.95*	1.40*†	1.70*†
Atlanta		1.90*		1.90*	1.75*	1.50*
Detroit (*2,600*)	1.70	1.70	1.60	1.60	1.35	1.35
Baltimore	1.40	1.40	1.60	1.60	.70‡*	.70‡*
Montreal	1.90*	1.50*	1.50*	1.50*	1.35*	1.25*
Birmingham (*2,700*)	1.54	2.00†	1.54	2.00†	1.19	1.50
Philadelphia (*2,950*)	2.25	2.25	2.25	2.25	1.65	1.65
Kansas City, Mo.					.66‡*	.66‡*
Pittsburgh	.85‡*	.85‡*	1.05‡*	.85‡*	1.25*	

*Per ton †Delivered ‡At pit. Note: New York, gravel weighs 2,800@ 3,000 lb. and sand, 2,700 lb.

CRUSHED STONE—Prices are for truckload lots, per cu.yd. Weight 1½ tons per cu.yd., unless otherwise specified in pounds:

	1½ In.		¾ In.	
	Feb. 2	One Year Ago	Feb. 2	One Year Ago
New York (*L*)	$1.75	$1.84	$1.85	$1.94
Chicago (*L*)	2.75†	1.70	2.75†	1.87½
St. Louis	1.73*	1.93*	1.73*	1.93*
Dallas	*2.30*	2.40	2.75	2.83
San Francisco (*T*) (*2,400*)	1.70	1.70	1.70	1.70
Boston (*on trucks at dock*)	2.00*	2.10*	2.00*	2.10*
Minneapolis (*T*) (*2,600*)	1.25*	1.75*	1.25*	1.75*
Kansas City (*G*) (*2,450*)	1.35*	2.00	1.35*	2.00
Denver (*G*) (*2,700*)	2.50	2.50	2.50	2.50
Seattle (*2,700*)	1.90		1.90	
Atlanta		2.50*†		2.50*†
Cincinnati	1.65*	1.65*	1.65*	1.65*
Los Angeles	2.10*†	2.10*†	2.10*†	2.10*†
Detroit ( ) (*2,600*)	2.60*	2.60*	2.60*	2.60*
Baltimore	2.50	2.50	2.55	2.55
Montreal	1.80*	1.80*	2.00*	2.00*
Philadelphia (*L*) (*2,590*)	2.25	2.25	2.25	2.25
Pittsburgh	2.75*	2.75*	2.75*	2.75*
Cleveland	2.70*	2.70*	2.70*	2.70*
Birmingham (*L*)	.85‡	2.00	1.00‡	2.00

* Per ton. † Delivered. ‡ At Crusher. *L*-Limestone. *G*-Granite. *T*-Trap rock.

CRUSHED SLAG—Price of crushed slag in carload lots, per net ton, at plant.

	1½-In.	¾-In.	Roofing	Sand
Youngstown District	$1.30	$1.40	$2.00	$1.30
Buffalo District	1.25	1.35	2.25	1.25
Birmingham, Ala.	.90	1.25	2.05	.80
Cleveland, Ohio	1.20	1.20		1.30
Eastern Pa. and Northern N. J.	1.25	1.25	2.00	1.25
Western Pennsylvania	1.25	1.25	2.00	1.25
Toledo, Ohio	1.25	1.25	1.50	1.25

LIME—Warehouse or wholesale prices:

	Hydrated, per Ton		Lump, per Barrel	
	Finishing	Common	Finishing	Common
New York	$17.20@18.20	$12.10	$3.25@$3.50*	$2.10@2.50*
Chicago (*del.*)	20.00	18.00		1.50†
St. Louis	23.50	17.50		2.03*
Boston	*18.50*	12.00	3.50*	2.25@2.50*
Dallas	19.00			1.82†
Cincinnati	16.80	11.90		11.40‡
San Francisco (*del.*)	27.50	24.50		1.70†
Minneapolis (*del.*)	25.50	21.00		1.70†
Denver	24.00			2.70*
Detroit	15.50	11.50		12.00‡
Seattle, *paper sacks*	24.00			2.80*
Los Angeles	26.00	18.00	2.40†	14.00‡
Baltimore	24.25	13.00	2.55†	
Montreal		21.00		10.00‡
Atlanta	*21.50*	12.50		1.25†
New Orleans				2.00*
Philadelphia	23.00	15.00		
Kansas City	28.00	24.00	2.66*	2.50*
Birmingham	22.50	16.00	2.40†	1.85†

*Per 280-lb. bbl. (net). †Per 180-lb. (net). ‡ Per ton.

NATURAL CEMENT—Price to dealers per bbl. for 500 bbl. or over, exclusive of bags:

	Feb. 2	One Year Ago
Minneapolis (Rosendale)	$2.80	$2.80
Kansas City (Ft. Scott)	1.45	1.45
Cincinnati (Utica)	1.72	1.72
Boston (Rosendale)	**2.45**	2.75
St. Louis (Carney)	2.60	2.35
Birmingham (Magnolia) pozzolan cement	2.40	2.40

PORTLAND CEMENT—Prices to contractors, per bbl. in carload lots, f.o.b. points listed, *without charge for bags*. Cash discount not deducted.

	Feb. 2	One Month Ago	One Year Ago
New York, del. by truck	$2.25@$2.35	$2.25@$2.35	$2.35@$2.50
New York, alongside dock to dealers	2.03	2.03	2.03
Jersey City	2.13	2.13	2.33
Boston	2.05	2.05	2.35
Chicago	2.05	2.05	2.05
Pittsburgh	2.04	2.04	2.04
Cleveland	2.24	2.24	2.24
Detroit	*1.90*	2.00	2.15
Indianapolis	2.19	2.19	2.19
Milwaukee	2.20	2.20	2.20
Duluth	2.04	2.04	2.04
Peoria	2.22	2.22	2.22
Cedar Rapids	2.24	2.24	2.24
Davenport	2.24	2.24	2.24
St. Louis	2.05	2.05	2.05@2.20
San Francisco	*2.41*	2.51	2.31
New Orleans	2.07	2.07	2.40
Minneapolis	2.22	2.22	2.22
Denver	2.85	2.85	2.85
Seattle	2.65	2.65	2.65
Dallas	2.05	2.05	2.05
Atlanta	2.45	2.45	2.25
Cincinnati	2.23	2.23	2.32
Los Angeles	2.50	2.50	2.50
Baltimore	2.50	2.50	2.50
Birmingham	2.40	2.40	2.30
Kansas City, Mo.	2.10	2.07	2.05
Montreal	1.41	1.41	1.41
Philadelphia	2.40	2.40	2.50
St. Paul	2.22	2.22	2.22
Toledo	2.20	2.20	2.20

NOTE—Bags 10c. each, 40c. per bbl.; 20c. each in Canada, 80c. per bbl.

Current mill-prices per barrel in carload lots, without bags, to contractors:

Buffington, Ind	$1.80	Hudson, N. Y.	$1.75
Universal, Pa	1.80	Leeds, Ala	1.65
Steelton, Minn	1.85	Hannibal, Mo	1.90
Fordwick, Va	2.05	Lehigh Valley District	1.75
Mitchell, Ind	1.90	Wyandotte, Mich	*1.65*
Iola, Kan	1.85	Alpena, Mich	1.60
Mason City, Ia	1.80	Kingsport, Tenn	2.05
La Salle, Ill	1.90	Clinchfield, Ga	1.65
Richard City, Tenn	$1.85		

E. N.-R. Prices of Construction Materials

TRIANGLE MESH—Price per 100 sq.ft. in carload lots at mills; from warehouse, in less-than-carload lots:

PLAIN 4-INCH BY 4-INCH MESH

Style Number	Weight in Pounds per 100 sq.ft.	Pittsburgh Mill	Chicago District Mill	Warehouse: New York	St. Louis	Dallas	San Francisco
032	22	$0.99	$1.01	$1.39	$1.06	$1.13	$1.22
049	28	1.26	1.29	1.76	1.35	1.38	1.55
068	35	1.54	1.58	2.16	1.66	1.67	1.91
093	45	1.98	2.03	2.77	2.13	2.00	2.46
126	57	2.45	2.51	3.45	2.63	2.55	3.03
153	68	2.92	2.99	4.11	3.14	3.15	.....
180	78	3.35	3.43	5.70	3.60	3.47	.....
245	103	4.43	4.53	6.21	4.75	4.58	.....
287	119	5.12	5.24	7.19	5.50	5.26	6.35
336	138	5.93	6.07	8.35	6.37	6.11	.....
395	160	6.88	7.04	9.65	7.38	7.12	.....
PAVING							
036P	17	$0.76	$0.77	$1.06	$0.81	$0.76	.....
053P	24	1.07	1.09	1.50	1.14	1.07	.....
072P	31	1.35	1.38	1.90	1.45	1.39	.....
097P	40	1.74	1.78	2.45	1.87	1.90	.....
049R	24	1.07	1.09	.....	1.14	1.02	.....
067R	31	1.35	1.38	.....	1.45	1.39	.....
089R	40	1.74	1.78	.....	1.87	1.90	.....

In rolls, 48-, 52-, and 56-in. wide and in 150-, 200- and 300-ft. lengths. Galvanized is about 15% higher. Size of roll carried in New York warehouses, 48 in. wide x 150 ft. long, or 600 sq.ft.

EXPANDED METAL LATH—Per 100 yd., painted, in less-than-carload lots:

Weight in pounds per yd.	New York	Birmingham	Chicago	St. Louis	*San Francisco	Dallas
2.2	$18.00	$21.00	$18.00	$18.00	$17.50	$22.00
2.5	19.00	22.00	19.00	19.00	18.50	23.50
3.0	21.00	24.50	21.00	21.00	21.00	26.50
3.4	22.50	26.50	22.50	22.50	23.00	29.00

*Carload lots, rail and water shipments.

BARS, CONCRETE REINFORCING—Price per 100 lb., in carload lots, f.o.b. Pittsburgh mill, and Birmingham. In other cities listed, prices are for bars out of stock at warehouse.

ROLLED FROM BILLETS

Inches	Pittsburgh	Birmingham	Warehouse: New York	Chicago	St. Louis	Dallas	San Francisco
½ and larger	$1.85	$2.00	$3.24	$2.30	$3.15	$2.75	$2.95
⅝	1.95	2.10	3.34	2.40	3.25	2.85	3.05
¾	2.05	2.20	3.44	2.50	3.35	2.95	3.15
⅞	2.25	2.40	3.64	2.70	3.55	3.10	3.35
1	2.85	3.00	4.24	3.30	4.15	3.75	3.95

For standard classification of extras for size and cutting of steel bars, see bar card of July 15, 1923.

ROLLED FROM RAILS

	St. Louis	Dallas		St. Louis	Dallas
½ in and larger	$2.20	$2.48	½	$2.60	$2.88
⅝	2.30	2.58	¾	3.20	3.48
⅞	2.40	2.68			

BRICK—Contractors price, f.o.b., per M, in cargo or carload lots, is as follows:

	Common: Feb. 2	Common: One Month Ago	Common: One Year Ago	Paving: 3x8½x4-in.	Paving: 3½x8½x4-in.
New York (del.*)	$16@18	$16@18	$20.40@22.40	$45.00†	$51.00†
New York (at dock)	14.00	14.00	17.00	.....	.....
Chicago	12.00	12.00	12.00	42.00	45.00
St. Louis, salmon (del.)	14.00	14.00	15.00	40.00	42.50
Denver, salmon	8@12	8@12	9@10	.....	.....
Dallas	13.50	13.50	14.10	35.00	.....
San Francisco	13.00	13.00	15.00	.....	.....
Los Angeles	10.00	10.00	10.50	(not used)	
Boston (del.)	17.50	17.50	19.50	45.00	55.00
Minneapolis (del.)	13.75	13.75	13.75	.....	.....
Kansas City	14.00	14.00	13.50	45.00	55.00
Seattle	14.00	14.00	15.00	.....	55.00
Cincinnati	15.50	15.50	15.50	40.00	45.00
Montreal (del.)	20.25	20.25	20.25	100.00‡	.....
Detroit (del.)	15.50	15.50	16.00	35.50	38.50
Baltimore	18.00	18.00	18.00	40.00	45.00
Atlanta	11.50	11.50	12.00	40.00	.....
New Orleans	14.00	13.00	15.00	60.00	75.00
Birmingham	14.50	14.50	14.50	40.00	45.00
Philadelphia (del.)	17.00	18.00	18.00	40.00	50.00
Pittsburgh (del.)	17.00	17.00	16.00	.....	.....
Cleveland	14@16	14@16	12@14	.....	.....

* By truck. † In cars. ‡ Imported.

HOLLOW TILE—Price per block in carload lots, f.o.b., to contractors, for hollow building tile.

	New York: Feb. 2 on Trucks*†	New York: One Year Ago	Chicago	Philadelphia	St. Louis	San Francisco†	Perth Amboy N. J., Factory*
4x12x12	$0.0966	$0.1027	$0.076	$0.105	$0.068	$0.108	.....
6x12x12	.145	.1541	.104	.....	.09	.156	.....
8x12x12	.1812	.1926	.142	.21	.126	.244	.....
10x12x12	.....	.....	.182	.....	.158	.....	$0.2432
12x12x12	.....	.....	.202	.32	.186	.....	3011

*5 per cent off for cash. †Partition tile.

	4x12x12	8x12x12	12x12x12
Boston	$0.08	$0.14	$0.235
Minneapolis	.072	.125	.225
Cincinnati	.064	.1295	.1726
Kansas City	.076	.138	.214
Denver	.085	.155	.22
Seattle	.10	.18	.26
Los Angeles	.085	.172	.285
New Orleans	.0808	.1516	.2232
Detroit	.068	.1326	.1853
Montreal	.12	.22	.315
Baltimore	.124	.268	.....
Atlanta	.068	.125	.....
Dallas	.103	.19	.31
Birmingham	.11	.124	.255
Pittsburgh	.068	.128	.179
Cleveland	.06	.12	....

STRUCTURAL MATERIAL—Following are base prices per 100 lb. in carload lots, f.o.b. Pittsburgh mill, and Birmingham. At other cities listed, quotations apply on less-than-carload lots from warehouses:

	Pittsburgh	Birmingham	Warehouse: New York	Dallas	St. Louis	Chicago	San Francisco
Beams, 3 to 15 in.	$1.85	1.90@$2.00	$3.34	$4.00	$3.25	$3.10	$3.15
Channels, 3 to 15 in.	1.85	1.90@2.00	3.34	4.00	3.25	3.10	3.15
Angles, 3 to 6 in., ¼ in. thick	1.85	1.90@2.00	3.34	4.00	3.25	3.10	3.15
Tees, 3 in. and larger	1.85	1.90@2.00	3.34	4.00	3.35	3.10	3.15
Plates, ¼ in. thick and heavier	1.85	1.90@2.00	3.34	4.00	3.25	3.10	3.15

RIVETS—The following quotations are per 100 lb.:

ROUND-HEAD STRUCTURAL

	Pittsburgh Mill	Warehouse: New York Feb. 2	New York One Yr. Ago	Chicago	St. Louis	San Francisco	Dallas
½ in.	$2.75	$5.00	$4.20	$3.60	$3.75	$5.75	$4.75
CONE-HEAD BOILER							
½ in.	$2.90	$5.00	$4.40	$3.60	$3.90	$5.75	$5.00
⅝ and ¾	3.05	5.15	4.55	3.70	4.10	5.90	5.15
⅞ and 1	3.30	5.40	4.80	3.95	4.15	6.10	5.50

NAILS—The following quotations are per 100 lb. keg from warehouse:

	Pittsburgh Mill	Birmingham	Chicago	San Francisco	Dallas	St. Louis	Montreal
Wire	$2.55	$2.85	$2.95	$3.25	$4.25	$2.83	$4.95
Cut	2.80	2.90	.....	4.90	5.00	2.88	5.00

SHIP SPIKES—Current prices per 100 lb.:

In	San Francisco: Galv	San Francisco: Black	Seattle Black
½	$7.30	$5.55	$7.75
⅝	6.85	5.10	5.65
¾	6.70	4.95	5.50

Pittsburgh base in lots of 200 kegs or more, $3.10.

PREPARED ROOFINGS—Slate-surfaced roofing in rolls weighing 85 to 90 lb. costs $1.93¾ per square to contractors in carload lots f.o.b. New York.

Single shingles, slate finish, cost $5.62½ per square (sufficient to cover 100 sq.ft.) in carload lots, f.o.b. New York. Strip shingles (4 in 1) f.o.b. New York, in carload lots to contractors, $4.27½ per square for the hexagonal shape, with Underwriters' label.

ROOFING MATERIALS—Prices f.o.b. New York, to contractors in carload lots:

Tarred felt per 100 lb	$2.94½
Asphalt coating, per gal	.31½
Asphalt felt, per 100 lb	3.09

WINDOW GLASS—United inches, 25, bracket size 6x8 to 10x15, single thickness "AA," 83 per cent; "A," 88 per cent; "B," 89 per cent. Double thickness "AA," 83 per cent; "A," 85 per cent; "B," 89 per cent discount from jobbers list at New York warehouses.

SHEETS—Quotations are per 100 lb. in various cities from warehouse also the base quotations at mill:

Blue Annealed	Pittsburgh Large Mill Lots	St. Louis	Chicago	San Francisco	New York
No. 10	$2.00@2.10	$3.60	$3.50	$3.75	$3.89
No. 12	2.05@2.15	3.65	3.55	3.80	3.94
No. 14	2.10@2.20	3.70	3.60	3.85	3.99
No. 16	2.20@2.30	3.80	3.70	3.95	4.04
Black					
Nos. 18 to 20	$2.60@2.70	4.25	3.75	4.60	4.00
No. 22	2.75@2.85	4.40	3.90	4.75	4.15
No. 24	2.80@2.90	4.45	3.95	4.80	4.20
No. 26	2.90@3.00	4.55	4.05	4.90	4.30
No. 28	3.05@3.15	4.70	4.20	5.05	4.45
Galvanized					
No. 10	$2.95@3.05	4.55	4.10	4.65	4.25
Nos. 12 to 14	3.05@3.15	4.65	4.20	4.75	4.35
No. 16	3.15@3.25	4.75	4.30	4.85	4.45
No. 18	3.30@3.40	4.90	4.45	5.00	4.60
No. 20	3.45@3.55	5.05	4.60	5.15	4.75
No. 22	3.50@3.60	5.10	4.65	5.20	4.80
No. 24	3.65@3.75	5.25	4.80	5.35	4.95
No. 26	3.90@4.00	5.50	5.05	5.60	5.20
No. 28	4.15@4.25	5.75	5.30	5.85	5.45

For galvanized corrugated sheets add 15c., all gages.

LINSEED OIL—These prices are per 7½-lb. gallon for raw oil:

	New York: Feb. 2	New York: One Year Ago	Chicago: Feb. 2	Chicago: One Year Ago
Raw in barrels (5 bbl. lots)	$0.76½	$0.84½	$0.78	$0.87

E. N.-R. Prices of Construction Materials

WHITE AND RED LEAD—Per 100-lb. keg, base price f.o.b. New York:

	Dry		In Oil	
	Feb. 2	1 Yr. Ago	Feb. 2	1 Yr. Ago
Red	$13.75	$15.25	$15.25	$16.75
White	13.75	15.25	13.75	15.25

Lumber

Prices wholesale, per M. ft. b.m., in carload lots, f.o.b.

San Francisco—Prices of rough Douglas fir No. 1 common, in carload lots to contractors at yards.

	6-8 and 12 Ft.	10-16-18 and 20 Ft.	22 and 24 Ft.	25 to 32 Ft.
3x3 and 4	$29.00	$30.00	$31.00	$34.00
2x6 and 8	29.00	30.00	31.00	34.00
4x4-6 and 8	29.00	30.00	31.00	34.00
3x10 and 12	29.00	30.00	31.00	34.00
3x14	33.00	33.00	34.00	37.00
4x10 and 12	29.00	30.00	31.00	34.00
4x14	33.00	33.00	35.00	37.00

	24 Ft. and Under	25 to 32 Ft.	33 to 40 Ft.
6x10	$31.00	$33.00	$35.00
6x14	37.00	39.00	41.00
8x10	31.00	33.00	35.00
8x14	37.00	39.00	41.00

New York and Chicago—Wholesale prices to dealers:

	New York		Chicago	
	20 Ft. and Under L.L.Y.P.	22-24 Ft. L.L.Y.P.	20 Ft. and Under No. 1 L.L.Y.P.	Up to 32 Ft. No. 1 Douglas Fir
3x4 to 8x8	$41.00@43.00	$42.00@44.00	$38.00	$39.50
3x10 to 10x10	48.00@50.00	49.00@51.00	45.00	39.50
3x12 to 12x12	55.00@57.00	56.00@58.00	55.00	39.50
3x14 to 14x14	63.00@65.00	64.00@66.00		39.50
3x16 to 16x16	75.00@77.00	76.00@78.00		40.50

New York—Prices are for long-leaf yellow pine timbers (rough) to dealers, alongside dock. Price to contractors, delivered by trucks from lighters to job, $5@$10 additional. Short leaf pine costs $3 per M. ft. less.

Over 24 ft.—Add $1 for each additional 2 ft. in length up to 32 ft. and $1 for each additional foot from 32 to 36 ft.

Other Cities—On cars or at dock:

	8x8-In. x 20 Ft. and Under				3x12 to 12x12-In. 20 Ft. and Under	
	P.	Fir*	Hemlock	Spruce	P.	Fir*
Boston	$48.00	$47.50	$49.00	$52.00	$57.50	$57.00
Seattle		24.00				20.00
New Orleans	45.00				46.50	
Baltimore	35.00	49.25	53.00	60.00	74.00	49.79
Cincinnati	33.00	46.00	44.00	44.00	37.00	50.00*
Montreal	50.00	55.00			60.00	50.00
Los Angeles		32.00		32.00		32.00
Denver		32.75	32.75	32.75	33.75	33.75
Minneapolis	44.25	37.75	36.25		48.25	38.25
Atlanta	31.00				34.00	
Dallas	56.00				56.00	
Kansas City, Mo.	40.50	38.75			54.50	38.25
Birmingham	32.00				34.00	
Philadelphia	48.00	35.00	40.00	45.00	60.00	35.00
Detroit	42.00	40.50			56.00	40.50
St. Louis	40.00				51.50	

	1-In. Rough, 10 In. x 16 Ft. and Under			2-In. T. and Gr. 10 In. x 16 Ft.	
	P.	Fir*	Hemlock	P.	Fir*
Boston	$43.50	$43.00	$44.50	$48.50	$48.00
Seattle		22.00			23.50
New Orleans	30.00			40.00	
Baltimore	55.00	44.00	44.00	34.00	49.50
Cincinnati	27.00	32.00	30.00	28.50	45.00
Montreal	45.00	55.00	40.00	65.00	50.00
Los Angeles		24.50			36.00
Denver		32.75	33.25		31.75
Minneapolis	39.75	35.25	34.75	33.75	33.25
Atlanta	22.00			28.00	
Dallas	52.25			56.00	
Kansas City, Mo.	50.75	38.75		40.00	36.75
Birmingham	27.00			45.00	
Philadelphia	32.00	35.00	37.00	50.00	35.00
Detroit	40.50	37.00		30.50	41.25
St. Louis	39.00			27.50	

*Douglas fir.

PILES—Prices per lineal foot, pine piles with bark on, f.o.b. New York:

Diameters	Points	Length	Barge	Rail
12 in. at butt	6 in.	30 to 50 ft.	$0.14½	$0.18½
12 in.—2 ft. from butt	6 in.	50 to 59 ft.	.19	.23½
12 in.—2 ft. from butt	6 in.	60 to 69 ft.	.21½	.25½
14 in.—2 ft. from butt	6 in.	50 to 69 ft.	.25½	.34
14 in.—2 ft. from butt	6 in.	70 to 79 ft.	.27½	.36½
14 in.—2 ft. from butt	5 in.	80 to 89 ft.	.35	.41

Miscellaneous

STEEL SHEETPILING—The following price is base per 100 lb. f.o.b. Pittsburgh, with a comparison of a month and a year ago:

Feb. 2	One Month Ago	One Year Ago
$2.20@$2.25	$2.20@$2.25	$2.25@$2.30

CONCRETE BLOCKS—Standard 8x8x16-in., delivered to job, each:

Denver	$0.22	St. Louis	$0.20
Detroit	.16	Boston	.18@.20
New Orleans	....	Minneapolis	.14*
Brooklyn and Queens	.18	Philadelphia	.18@.20
Pittsburgh	.18	*F.o.b.	

WIRE ROPE—Discounts from list price on regular grades of bright and galvanized are as follows:

	Eastern Territory New York and East of Missouri River
Plow steel round strand rope	35%
Special steel round strand rope	30%
Cast steel round strand rope	20%
Round strand iron and iron tiller	5%
Galvanized steel rigging and guy rope	7½%
Galvanized iron rigging and guy rope (*old to list*)	12½%

California, Oregon, Nevada and Washington: Discount 5 points less than discount for Eastern territory.

Wyoming, New Mexico and Colorado: Discount 5 points less than discount for Eastern territory.

Arizona: Discount 10 points less than discount for Eastern territory.

Montana, Idaho and Utah: Discount 10 points less than discount for Eastern territory.

North Dakota, Nebraska, Kansas, Oklahoma and Texas: Discount 5 points less than discount for Eastern territory.

MANILA ROPE—For rope smaller than ¼-in. the price is ½ to 2c. extra; while for quantities amounting to less than 600 ft., there is an extra charge of 1c. The number of feet per pound for the various sizes is as follows: ¼-in., 8 ft.; ⅜-in., 6; ½-in., 4½; 1-in., 3½; 1½-in., 2 ft. 10 in.; 1½-in., 2 ft. 4 in. Following are prices per pound for ¾-in. and larger, in 1200-ft. coils:

Boston	$0.25	New Orleans	$.23½
New York	.26	Los Angeles	.25
Chicago	.22	Seattle	.23
Minneapolis	.21½	St. Louis	.23
San Francisco	.23	Montreal	.17
Atlanta	.22	Detroit	.24½
Denver	.24@.25	Baltimore	.26
Cincinnati	.21	Kansas City	.21½
Dallas	.31	Birmingham	.26@.27
Philadelphia	.25		

EXPLOSIVES—Price per pound for dynamite in small lots:

	Gelatin 40%	Gelatin 60%
New York	$0.265*	$0.2875*
Boston	.24	.27
Kansas City	.22	.225
Seattle	.165	.19
Chicago	.195†	.2175†
Minneapolis	.1917	.2123
St. Louis	.22	.24½
Denver	.2025	.2275
Dallas	.225	.306
Los Angeles	.1875	.2225
Atlanta	.245	.255
Baltimore	.22	.23
Cincinnati	.22	.245
Montreal	.195	.22
Birmingham	.22	.24
New Orleans	.235	.26
San Francisco	.1625	.1925
Philadelphia	.215	.24

*Special gelatin in case lots. †Quantities above 500 lb., and less than a ton.

CHEMICALS—Water and sewage treatment chemicals, round lots at New York:

Sulphate of aluminum, in bags, per 100 lb.	$2.00@$2.10
Sulphate of copper, in bbl., per 100 lb.	5.00@ 5.10
Soda ash, 58%, in bags, per 100 lb.	1.32@ 1.35
Chlorine, liquid, cylinders, per lb.	.05½@ .08
Hypochlorite of lime (bleaching powder) in drums, per 100 lb.	2.00@2.10*

*F. o. b. works.

FREIGHT RATES—On finished steel products in the Pittsburgh district, including plates, structural shapes, merchant steel, bars, pipe fittings, plain and galvanized wire nails, rivets, spikes, bolts, flat sheets (except planished), chains, etc., the following freight rates are effective in cents per 100 lb., in carloads of 36,000 lb. or 18 tons:

Atlanta	$0.58	Detroit	$0.29
Baltimore	.31	Kansas City	.735
Birmingham	.58	New Orleans	.67
Boston	.365	New York	.34
Buffalo	.265	Pacific Coast (all rail)	1.15*
Chicago	.34	Philadelphia	.32
Cincinnati	.29	St. Louis	.43
Cleveland	.19	St. Paul	.60
Denver	1.15*		

* Minimum carload, 50,000 lb., structural steel only; 80,000 lb., for other iron or steel products.